Volume 34 NOVEMBER, 1960 Number 6

JOURNAL OF PALEONTOLOGY

UNIVERSITY OF MICHIGAN
DEC 18
MUSEUMS LIBRARY

A publication of The Society of Economic Paleontologists and Mineralogists and The Paleontological Society with the generous support and cooperation of The American Association of Petroleum Geologists and The Geological Society of America

CONTENTS

Astogenetic study of fenestrate bryozoans ..... *T. G. Perry and Donald E. Hattin* 1039

Some fusulinids from the upper Strawn, Pennsylvanian, of Texas ..... *Wendell J. Stewart* 1051

Cephalopods from the Burgess Formation in Missouri ..... *A. G. Unklesbay and Ernest J. Palmer* 1071

Anisoceras and *Ancyloceras* from the Texas Cretaceous ..... *David L. Clark* 1076

An Upper Devonian conodont fauna from the Darby Formation of the Wind River Mountains, Wyoming ..... *Gilbert Klapper* 1082

Novojilov's classification of fossil conchostracans—a critical evaluation. Part I. Family Leaiidae ..... *Paul Tasch* 1094

The genera, species and subspecies of the Family Eurypteridae, Burmeister, 1843 ..... *Erik N. Kjellesvig-Waering* 1107

PALEONTOLOGICAL NOTES

Geologic range and subdivisions of the *Stictopora* small *Asiana* patterings ..... *Dwight W. Taylor* 1149

A new Cretaceous echinoderm horizon from Louisiana ..... *E. Ann Bailey and Alan Chisholm* 1153

The complex homeomorphs *Taphrogonites* and *Streptognathodus* ..... *Carl B. Rexroad* 1158

SOCIETY RECORDS AND ACTIVITIES

Memorial to Charles Wade Dudley ..... *Raymond C. Moore* 1160

Announcement of meetings 1162

INDEX 1163

EDITORS

For The Society of Economic Paleontologists and Mineralogists: M. L. Thompson and Charles W. Collinson, Illinois State Geological Survey, Urbana, Illinois.

For The Paleontological Society: Erwin C. Stumm, Museum of Paleontology, University of Michigan, Ann Arbor, Michigan.

The Journal of Paleontology is published bimonthly. The issues for January, May, and September are sponsored by The Paleontological Society in cooperation with The Geological Society of America; those for March, July, and November are sponsored by The Society of Economic Paleontologists and Mineralogists in cooperation with The American Association of Petroleum Geologists.

The subscription price for the Journal is $15.00 per year prepaid to addresses in the United States. Postage is charged extra for all other countries in the Postal Union, 40 cents on journal subscriptions (total $15.40). Single numbers $3.00 each to nonmembers, $1.75 to members.

Communications about the Journal, advertising, subscriptions, rates, change of address, and nonreceipt of preceding numbers, should be addressed to The Society of Economic Paleontologists and Mineralogists, P. O. Box 979, Tulsa 1, Oklahoma. Claims for nonreceipt of preceding numbers must be submitted within three months of the date of publication in order to be filled gratis. Communications about membership and requests for blanks for nomination of new members should be directed to the secretary of the respective society.

Communications in regard to manuscripts or purely editorial matters should be sent to the editors at addresses above.

Authors should consult a recent issue of the Journal for appropriate style and form before preparing their manuscripts. A brief, informative abstract should accompany every article except nomenclatural notes only one or two paragraphs long in which the title is sufficient to serve as an abstract of the contents. All new taxonomic names proposed in a paper should appear in the abstract.

Contributors are requested to instruct their photographers to illuminate fossils from the upper left side, the conventional manner. Plates normally should be arranged for publication at the maximum size of 5¼ × 8¼ inches, exclusive of margins and heading. Printed numerals of standard size and form may be obtained free from the editors. When requesting them state number of plates and dimensions of each plate. Text figures should be designed for reproduction at either single column (2⅛ inches) or full page (5⅞ inches) width, maximum height 7⅞ inches. Typewritten copy is not acceptable for text figures.

OFFICERS OF THE SOCIETIES

THE SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS

For the year ending March 1939

President

Gordon Rittenhouse, Houston, Texas

Past-President

R. V. Hollingsworth, Midland, Texas

Vice-President

William M. Furnish, Iowa City, Iowa

Secretary-Treasurer

Raymond E. Peck, Columbia, Missouri

Editors

M. L. Thompson and Charles W. Collinson, Urbana, Illinois, for Paleontology

Jack R. Hoover, Urbana, Illinois, for Mineralogy

THE PALEONTOLOGICAL SOCIETY

For the year ending November 1939

President

Frank M. Swartz, University Park, Pa.

Vice-President

William R. Evitt, Tulsa, Oklahoma

Secretary

Harry B. Whittington, Cambridge, Mass.

Treasurer

Claude C. Albritton, Dallas, Texas

Editors

Erwin C. Stumm, Ann Arbor, Mich.

Robert V. Kesling, Ann Arbor, Mich.

Past-Presidents

Arthur K. Miller, Iowa City, Iowa

G. Arthur Cooper, Washington, D. C.

Kenneth E. Stumm, Houston, Texas

Second-class postage paid at the Post Office at MENASHA, WISCONSIN, and at additional mailing office, under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in paragraph 4, section 538, P. L. and R., authorized April 1, 1935.

Printed in U. S. A.

GEORGE BANTA COMPANY, INC., MENASHA, WISCONSIN

JOURNAL OF PALEONTOLOGY

A publication of THE SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS *and* THE PALEONTOLOGICAL SOCIETY *with the generous support and cooperation of* THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS *and* THE GEOLOGICAL SOCIETY OF AMERICA

VOLUME 32 NOVEMBER, 1958 NUMBER 6

ASTOGENETIC STUDY OF FISTULIPOROID BRYOZOANS

T. G. PERRY AND DONALD E. HATTIN
Indiana University, Bloomington, Indiana

ABSTRACT—The purpose of this study is to determine if structural changes took place during the astogeny of three species of fistuliporoid bryozoans. This investigation is based on *Dybowskiella brownsportensis* n. sp. and *Fistulipora hemisphaerica* (Roemer) from the Brownsport formation (Niagaran) of west-central Tennessee and *Cyclotrypa* cf. *C. abdita* Moore & Dudley from the Beil limestone member of the Lecompton formation (Virgilian), Coffey County, Kansas. Thin sections were prepared to show structural conditions at different stages in the zoarial development of these species. The authors conclude that: (1) internal structures and characters commonly used in specific differentiation of fistuliporoids remain relatively constant during the astogeny of these species, (2) interzooecial (vesicular) tissue, as revealed in longitudinal section, commonly displays great structural variability within a single zoarium and seemingly has little value in differentiating fistuliporoid species, and (3) zoarial growth did not proceed uniformly in most of the zoaria studied. Comments are made concerning the relationship of the fistuliporoid genera *Dybowskiella*, *Fistulipora*, and *Cyclotrypa*.

INTRODUCTION

THE astogeny of Paleozoic trepostomatous and cryptostomatous Bryozoa has been studied by several paleontologists (Cumings, 1904, p. 49–78; 1905, p. 169–177; Lee, 1912, p. 137–195; Boardman, 1954, p. 322,323). Boardman has shown recently that the number of diaphragms, breadth of the cortical region, thickness of zooecial walls, and angle at which zooecia intersect the zoarial surface display considerable variation within the colony and refutes the concept held by Lee (1912, p. 143) that the axial ratio (ratio of the diameter of the axial region to the diameter of the branch) remains a constant specific character throughout the colony. In contrast, studies concerned with structural changes in Paleozoic cyclostomatous Bryozoa have not been made. Crockford (1957, p. 9) states that the lunaria and interzooecial tissue in some Paleozoic Cyclostomata show changes in character in different astogenetic stages but does not describe the nature of the changes.

In describing and studying Bryozoa, tangential sections oriented as closely as possible to the surface of the zoarium are generally prepared. Data of a specific and generic nature are obtained from examination of tangential sections as well as from longitudinal sections which are oriented parallel to the direction of zooecial growth. Obviously, the tangential section cannot indicate structural changes that may have occurred during development of the colony. The longitudinal section will, however, reveal structural changes, if any, that are associated with astogeny, such as variation in character of the interzooecial tissue, number of diaphragms, and other features. If, how-

ever, tangential sections are prepared at variable distances or depths from the surface, then certain structural changes that are associated with astogeny can be observed.

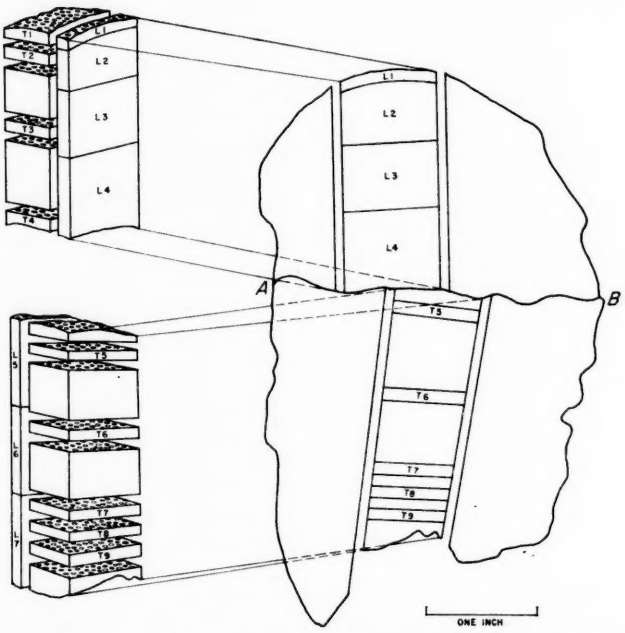
In fistuliporoid bryozoans considerable emphasis is placed on the prominence of the lunarium, abundance of interzooecial tissue, interzooecial distance, and zooecial diameter as specific characters; these features are best observed in tangential section. In order to demonstrate the behavior of these characters during development of a colony, sections normal to the direction of zooecial growth are prepared at different levels within the zoarium; such sections reveal structure at several stages in colonial development. These serial tangential sections, studied in conjunction with longitudinal or serial longitudinal sections where large zoaria are involved, afford insight into astogenetic structural change.

Professor H. J. Meessen, Chairman of the Department of German at Indiana University, translated Roemer's original description of *Thecostegites* (*Fistulipora*) *hemisphaericus*. Thin sections used in this study were largely prepared by Mr. William T. Straw, an undergraduate student in geology at Indiana University. Photographs of specimens and thin sections were prepared by Mr. George Ringer of the Indiana Geological Survey. Drafting was supervised by Mr. William H. Moran also of the Indiana Geological Survey. The Brownsport specimens used in this study form a small part of a bryozoan collection from the formation which was made by the senior author with financial assistance of a research grant from the Geological Society of America.

Material studies

Sources of specimens.—This study is based specifically on the zoaria of three distinct species of fistuliporoids, one from strata of Pennsylvanian age and the remaining species from beds of Silurian age. The Pennsylvanian specimen was collected in a stream bed that crosses the Lecompton limestone (Virgilian) approximately four miles southeast of the town of Strawn, Coffey County, Kansas, in T. 21 S., R. 14 W. The exposure is limited to a few feet of strata that are referred to the Beil limestone member of the Lecompton. In the Strawn area, the Beil comprises approximately 3.5 feet of light- to medium-gray yellow-brown-weathering limestone that is medium- to thick-bedded. Subordinate amounts of medium-gray shale can be observed locally. Fistuliporoid Bryozoa are a common element in the diversified and generally well preserved Beil fauna. The Silurian specimens were obtained from the Brownsport formation (Niagaran) of west-central Tennessee. Brownsport specimens used in this study were obtained from the following localities: (1) approximately two miles south of the village of Perryville, 900 feet southeast of a road leading from Perryville to Decaturville. Decatur County, Tennessee, (2) one and four-tenths miles south of Hall School, 250 feet east of a poor road, Perry County, Tennessee, and (3) approximately two miles south of Perryville, 700 to 800 feet northwest of a road connecting Perryville and Decaturville, Decatur County, Tennessee. Specimens from Locality 1 were obtained from the lower 26 feet of the Brownsport; from Locality 2 in the upper 25 feet of the formation; and from Locality 3 in the upper 20 feet of the so-called Beech River member of the Brownsport formation. The Brownsport includes gray and green-gray calcareous shale; drab yellowish-gray argillaceous limestone; and buff to gray fine- to medium-grained nonargillaceous limestone. Thin-bedded shale and highly argillaceous limestone predominate. The fauna, exclusive of Bryozoa, of this richly fossiliferous formation has been described recently by Amsden (1949). The Brownsport bryozoan fauna is now under study by T. G. Perry.

Procedure.—Opportunity for studying astogeny of a Pennsylvanian fistuliporoid was afforded by a well preserved colony of *Cyclotrypa* cf. *C. abdita* Moore & Dudley that was collected by the junior author. The specimen (Pl. 129, figs. 5,6) measured approximately six inches in length and three inches in diameter. Careful determination of zooecial tube orientation provided information necessary for sectioning the specimen; a saw cut was then made along the greater dimension of the colony. Text-figure 1 illustrates the sawn surface of one-half of the specimen and shows the positions from which two blocks were cut for the purpose of



TEXT-FIG. 1—Sketch of zoarium of *Cyclotrypa* cf. *C. abdita* Moore & Dudley showing positions of serial tangential and serial longitudinal sections within the colony. A–B marks plane of rejuvenation.

making thin sections. As shown in Text-figure 1, a major surface of rejuvenation (A–B) lies about midway on the sawn surface of the first cut. Because of changes in zooecial orientation at the growth discontinuity, it was necessary to cut longitudinal sections from the front of one block and from the back of the second. Positions from which the tangential and longitudinal sections were taken are shown clearly in the text-figure.

Serial tangential sections of specimens of *Fistulipora hemisphaerica* (Roemer) were prepared from the colony base to the upper zoarial surface. A single longitudinal section sufficed to show structures related to astogeny.

Dybowskiella brownsportensis n. sp. has a ramose zoarium. Astogenetic changes, where present, can be observed in transverse section (normal to length of zoarium) as well as in longitudinal section because the former expectably reveals any developmental changes in zooecial diameter, prominence of lunaria, and interzooecial distance.

SYSTEMATIC DESCRIPTIONS

Order CYCLOSTOMATA

Family FISTULIPORIDAE Ulrich, 1882

Genus FISTULIPORA McCoy, 1850

FISTULIPORA HEMISPHAERICA (Roemer), 1860

Pl. 129, figs. 1–4

Thecostegites hemisphaericus ROEMER, 1860, Verlag von Eduard Trewendt, Breslau, p. 25,26, pl. 2, figs. 3,3a; MILLER, 1889, N. American Geol. Paleont., Western Methodist Book Concern Press, p. 207, fig. 228.

Literal translation of original description.—"A half spherical coral colony 1 to 2 inches in diameter which is covered on its entire surface with small circular cell openings distributed irregularly and separated by intervals from the compact coral mass, on the other hand shows only concentric wrinkles on the flat underside. At first glance the species resembles *Chaetetes Petropolitanus*, however upon closer investigation one soon recognizes that the cell mouths are not as there [in *Chaetetes Petropolitanus*], polygonal and immediately adjoining but circular and separated by intervals of one- or two-fold di-

ameter of the cell mouths themselves. The kind of distribution of the cell mouths is approximately as in the case of *Heliolites*, however whereas there [in *Heliolites*] also the intervals between the cell mouths are porous these intervals appear here [in *Thecostegites hemisphaericus*] at least on the surface quite compact without pores and holes. Also the radiating lamellae in the interior of the cell mouths are lacking. A distinct ridge usually somewhat protruding surrounds the cell mouths.

"All these characteristics on the other hand fit well the genus *Thecostegites* of M. Edwards and Haime. However I am by no means certain of the affinity of the American fossil to the above mentioned genus of the French authors but I associate them only with doubt. For on the one hand in the specimens on hand it has not been possible to demonstrate the internal structure and on the other the cell mouths are of striking smallness by comparison to those of the remaining species of *Thecostegites*. In the smaller specimens, they [cell mouths] are only point-shaped openings like needle-pricks and barely recognizable to the naked eye. If the surface is weathered, the calyx mouths are much wider and the similarity with *Calamopora* or *Chaetetes* appears then even greater. But even then the calices are separated by much thicker walls than in the last named genera.

"Occurrence: Seven specimens are at hand of which 6 have a diameter of approximately 1 inch but the 7th a diameter of 2½ inches.

"Explanation of plate: Fig. 3. Lateral view of a specimen in natural size. Fig. 3a. A piece of the surface enlarged."

Description of types.—Zoarium massive, hemispherical, concave or plane at base, evenly convex upward; zoarium commonly as much as 30 mm. in diameter and 10 mm. in maximum thickness. Maculae irregularly distributed, inconspicuous, and flanked by zooecia somewhat above average in size.

In tangential section, zooecia thin-walled, circular or subcircular; typically 3 entire zooecia and a portion of a 4th in 2 mm., commonly 4 entire zooecia in this distance, and less commonly 3 entire zooecia in 2 mm.; maximum zooecial diameter ranges from 0.33 to 0.41 mm., averaging 0.37 mm. for 40 measurements; number of zooecia in a 4-mm. square area, not including a macula, ranges from 39 to 52, averaging 46 for 11 measurements. Lunarium nonthickened, not indenting zooecial cavity, typically broadly arched, occupying one-quarter to one-third of zooecial periphery, and not discernible on all zooecia. Vesicles generally approximate zooecia in size, ranging from about one-half to somewhat larger than zooecia in size; almost invariably 1 vesicle between adjacent zooecia which are nowhere in contact; interzooecial distance averages 0.22 mm., ranging from 0.11 to 0.43 mm. in 73 measurements with only 1 measurement above 0.40 mm. Maculae, generally less than 1.25 mm. in diameter, composed of large irregularly polygonal vesicles; zooecia on flanks of macula somewhat above average in size and with lunaria directed toward center of macula.

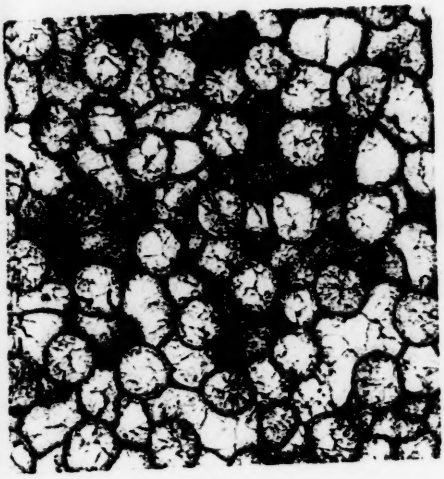
In longitudinal section, zooecia emanate upward and outward from center of concave or plane base, this zooecial growth form being most conspicuous in small zoaria; zooecial walls thin throughout zoarium. Diaphragms thin, horizontal or somewhat inclined, irregularly distributed in zooecia, generally spaced less than 1 zooecial diameter to somewhat over 1 zooecial diameter

---

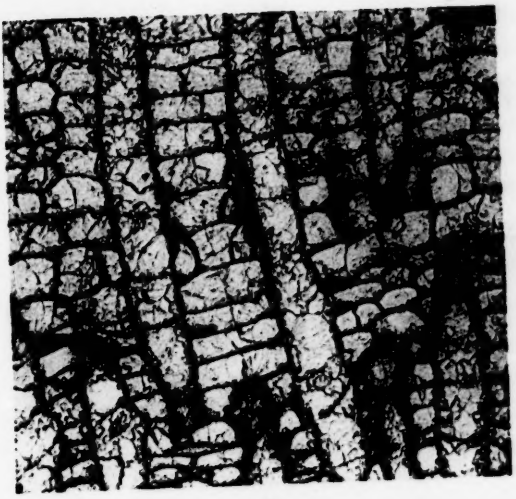
EXPLANATION OF PLATE 129

FIGS. *1–4*—***Fistulipora hemisphaerica*** (Roemer). Neoholotype (Ind. Univ. Paleont. Coll. 5485) from the Brownsport formation (Niagaran) south of Hall School, Perry County, Tennessee, each ×20. *1*, Tangential section from near zoarial surface; *2*, tangential section midway between zoarial surface and base of colony; *3*, tangential section from base of colony; *4*, longitudinal section.

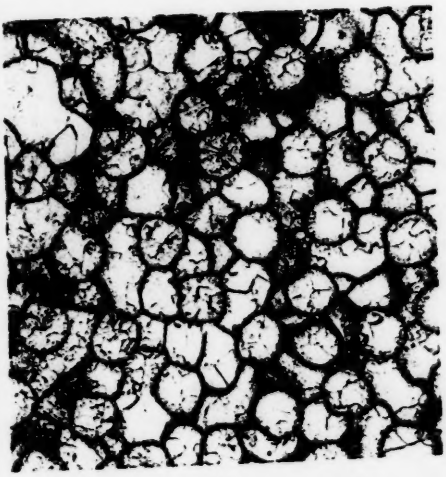
5–6—***Cyclotrypa*** cf. ***C. abdita*** Moore & Dudley. External views of specimen (Ind. Univ. Paleont. Coll. 5489) from the Beil limestone member of the Lecompton formation (Virgilian) southeast of Strawn, Coffey County, Kansas. *5*, Longitudinal view of weathered zoarium, ×1.7; *6*, zoarial surface showing typical monticules, ×3.3.



1

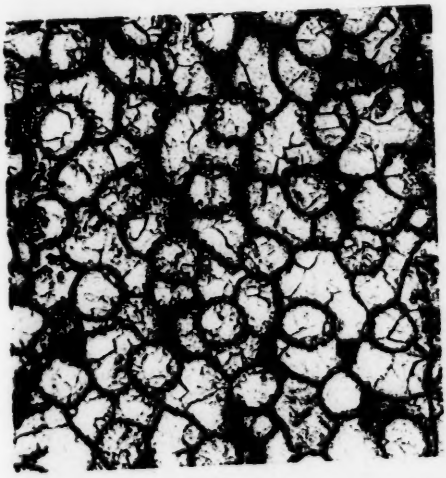


4

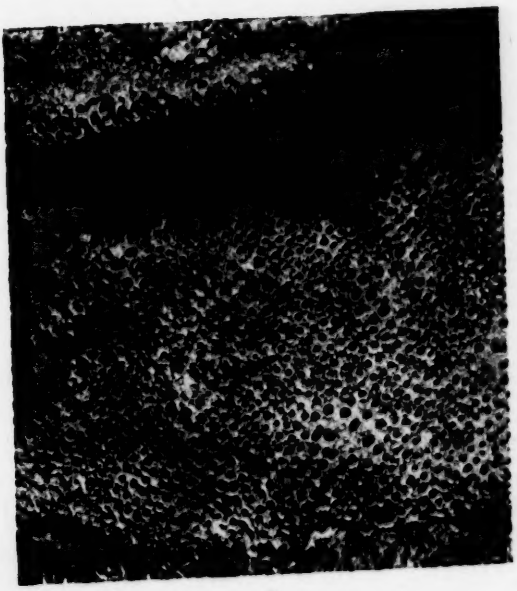


2

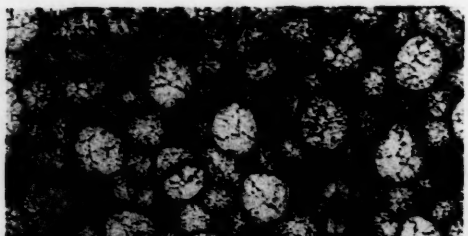
5



3



6



apart; zooecia rarely devoid of diaphragms for as much as a 3-mm. distance, possibly as a result of recrystallization. Vesicles coarse, crescentic, convex upward, and typically arranged in mutually imbricating or interlocking columns; zones, usually less than 1.0 mm. thick, of thin vesicles extend throughout zoarium or grade laterally into tissue composed of vesicles of normal size.

Remarks.—Bassler (1915, p. 539) assigned this species to the genus *Fistulipora*. The authors agree with this assignment, although the lunarium is inconspicuous on some zooecia and absent on others.

Roemer did not comment on the internal structure of this species, and his specimens cannot be located for study. The authors are confident that our specimens are conspecific with those on which Roemer based his description and illustrations for the following reasons: (1) our specimens were collected from the same general area as Roemer's material, (2) the external appearance of the zoarium of the specimens in question is distinctive, (3) our specimens represent an extremely abundant species in the Brownsport formation of west-central Tennessee, and (4) Roemer's illustration of an enlarged surficial portion of the colony indicates clearly that the zooecial apertures are essentially round and lack conspicuous lunaria. The specimen illustrated by Roemer presumably underwent repeated rejuvenation.

Although the foregoing description was based on the neoholotype and three neoparatypes used in this study, the senior author examined thin sections of more than 100 specimens of *F. hemisphaerica* and measured maximum zooecial diameter, interzooecial distance, and number of entire zooecia in an area 4 mm. square in 25 typical specimens; these measurements were made on tangential sections of customary orientation. In order that the reader may have a better understanding of this species, measurements of 25 typical specimens follow: maximum zooecial diameter (based on 128 measurements) ranges from 0.26 to 0.51 mm., averaging 0.37 mm.; interzooecial distance (based on 264 measurements) ranges from 0.07 to 0.52 mm., averaging 0.22 mm.; and number of entire zooecia in an area 4 mm. square (not including a macula and based on 50 measurements) ranges from 30 to 52, averaging 40.

Examination of Table 1 shows clearly that ranges of maximum zooecial diameter, interzooecial distance, and number of entire zooecia in an area 4 mm. square in intermediate and basal sections lie within the limits of variability for this species. Intermediate section of Table 1 is located midway between the zoarial surface and the base of the colony; basal section of Table 1 is located as closely as possible to the base of the zoarium; both sections are oriented normal to direction of zooecial growth. Further, as is shown in Plate 129, figures 1–3, the lunarium does not change appreciably during development of the colony. The authors conclude that, insofar as maximum zooecial diameter, interzooecial distance, and number of entire zooecia in an area 4 mm. square are concerned, changes in these characters during astogeny do not exceed normal structural variability of this species.

Occurrence.—Brownsport formation (Niagaran) of west-central Tennessee in which it can be found abundantly at many exposures.

Types.—Indiana University Paleontologic Collections; neoholotype specimen and slide 5485; neoparatype specimens and slides 5486–5488.

EXPLANATION OF PLATE 130

All figures are ×20.

FIGS. *1–6*—*Cyclotrypa* cf. *C. abdita* Moore & Dudley. Specimen (Ind. Univ. Paleont. Coll. 5489) from the Beil limestone member of the Lecompton formation (Virgilian) southeast of Strawn, Coffey County, Kansas. *1*, Tangential section (T1) from near zoarial surface; *2*, tangential section (T4), nearly midway between zoarial surface and base of colony; *3*, tangential section (T8) from near base of colony; *4*, longitudinal section (L2) from near surface of zoarium; *5*, longitudinal section (L5), nearly midway between zoarial surface and base of colony; *6*, longitudinal section (L7) from near base of colony. See Text-fig. *1* for positions in zoarium of all sections.

TABLE 1.—MEASUREMENTS OF *F. Hemisphaerica*

Figure in ( ) indicates number of measurements. Neoholotype is specimen 5485.

Specimen and Section	Maximum zooecial diameter in mm.	Interzooecial distance in mm.	Number of zooecia in 4 mm.² area
5486 Tangential Section	Average 0.38 Range 0.33–0.41 (10)	Average 0.20 Range 0.11–0.34 (19)	52, 50, 50
5486 Intermediate Section	Average 0.39 Range 0.33–0.42 (10)	Average 0.19 Range 0.12–0.29 (19)	44*, 40*
5486 Basal Section	Average 0.35 Range 0.30–0.38 (10)	Average 0.22 Range 0.09–0.31 (16)	46, 49, 43
5487 Tangential Section	Average 0.37 Range 0.33–0.39 (10)	Average 0.24 Range 0.14–0.31 (17)	40, 43, 45
5487 Intermediate Section	Average 0.33 Range 0.29–0.36 (10)	Average 0.27 Range 0.16–0.33 (15)	40*, 44*
5487 Basal Section	Average 0.30 Range 0.27–0.31 (10)	Average 0.26 Range 0.16–0.32 (16)	44*, 44*
5485 Tangential Section	Average 0.37 Range 0.34–0.40 (10)	Average 0.23 Range 0.15–0.43 (19)	48, 51, 48
5485 Intermediate Section	Average 0.37 Range 0.36–0.40 (10)	Average 0.22 Range 0.16–0.31 (18)	50, 42, 43
5485 Basal Section	Average 0.36 Range 0.34–0.40 (10)	Average 0.21 Range 0.15–0.35 (16)	42, 42, 43
5488 Tangential Section	Average 0.37 Range 0.35–0.40 (10)	Average 0.23 Range 0.11–0.33 (18)	39†, 42
5488 Intermediate Section	Average 0.37 Range 0.34–0.41 (10)	Average 0.21 Range 0.09–0.43 (17)	48, 45, 42
5488 Basal Section	Average 0.35 Range 0.32–0.40 (10)	Average 0.21 Range 0.11–0.25 (17)	42*, 48*

* Number of zooecia in a 2×4 mm. area×2.
† Includes small part of macula.

Genus CYCLOTRYPA Ulrich, 1896
CYCLOTRYPA cf. C. ABDITA Moore & Dudley, 1944
Pl. 129, figs. 5,6; Pl. 130, figs. 1–6
Text-fig. 1

Cyclotrypa abdita MOORE & DUDLEY, 1944, Geol. Survey Kansas, Bull. 52, Pt. 6, p. 279,280, pl. 12, fig. 4, pl. 21, fig. 1, pl. 26, fig. 1, pl. 35, fig. 2.

Zoarium massive, elevated hemispherical, with shallow basal concavity and smoothly rounded summit; maximum length and diameter of zoarium 14.9 and 7.3 cm. respectively. Monticules low, commonly having somewhat depressed center, and spaced generally 5 to 9 mm. apart, measuring from center to center; monticule center generally

devoid of zooecia but containing vesicular tissue; zooecial apertures on flanks of monticule usually slightly elongate and having lunaria directed toward center of monticule.

In tangential section (T1), zooecia thin-walled, broadly ovate or subcircular; maximum zooecial diameter ranges from 0.26 to 0.44 mm., averaging 0.38 mm.; nine of the 10 measured zooecia are 0.32 mm., or more, in diameter; number of entire zooecia in 2 mm. generally 4, but in 2 of the 10 measurements only a major portion of the 4th zooecium included in this distance; number of entire zooecia in a 4-mm. square area, not including monticule, ranges from 44 to 47 for 3 measurements. Lunarium not thickened, not indenting zooecial cavity, broadly arched, and not distinctly observable in many zooecia. Adjacent zooecia nowhere in contact, almost invariably separated by 1 vesicle; interzooecial distance ranges from 0.11 to 0.33 mm., averaging 0.21 mm. for 18 measurements; vesicles polygonal or subpolygonal and smaller in size than zooecia. Center of monticule composed of irregularly polygonal vesicles of variable size.

In longitudinal section, zooecia erect, thin-walled. Diaphragms thin, horizontal or somewhat inclined, and in longitudinal sections 1 to 4, inclusive, generally spaced from less than 1 zooecial diameter apart to approximately 1 zooecial diameter apart; in longitudinal sections 5 to 7, inclusive, diaphragms lacking through a 5-mm. length in some zooecia possibly because of recrystallization, but locally are spaced 1 zooecial diameter, or somewhat more, apart. Interzooecial tissue typically consists of regularly arranged, crescentic, imbricating or interlocking vesicles convex outward; vesicles generally increase in coarseness or size with increasing depth below surface of zoarium; zones, usually less than 1 mm. thick, of thin vesicles common and grade laterally into normal interzooecial tissue; vesicles generally thinner directly below planes of rejuvenation.

Remarks.—This specimen is probably conspecific with *C. abdita* Moore & Dudley from the Clay Creek limestone member of the Kanwaka shale of Virgilian age near Lecompton, Kansas. Moore & Dudley (1944, p. 279) state that the zooecial diameter averages 0.35 mm., ranging from 0.32 to 0.36 mm. and the interzooecial distance ranges from 0.18 to 0.32 mm., averaging 0.25 mm. The type figure shows that 4 zooecia occupy a 2-mm. distance, although only a portion of the 4th zooecium may be included herein. The type figure further shows that 12 entire zooecia are found in an area 2 mm. square, *viz.* 48 in an area 4 mm. square.

Consideration was given to referring this specimen to *C. pelagia* Moore & Dudley, a species showing considerable structure variability. The illustration of the type figure (Moore & Dudley, pl. 18, fig. 4) shows that the interzooecial vesicles are smaller than in our specimen. Consideration was also given to assigning this specimen to *C. capacis* Moore & Dudley, also showing considerable structural variability, but our specimen displays somewhat greater constancy of structure than this species.

We assign this specimen to *Cyclotrypa* and not *Fistulipora* as many zooecia lack a lunarium and, where developed, this structure is inconspicuous.

Tabulated measurements of maximum zooecial diameter, interzooecial distance, and number of zooecia in a 4-mm. square area for each of the serial tangential sections of *Cyclotrypa* cf. *C. abdita* are presented in Table 2. Except for a slight decrease in average maximum zooecial diameter and correspondingly small increase in number of zooecia in a 4-mm. square area near the zoarial surface, the structural features considered show noteworthy constancy throughout the zoarium. Because zooecia are irregularly oriented in T9, measurements of this section are not given in Table 2.

Occurrence.—Beil limestone member of Lecompton limestone (Virgilian) 4 miles southeast of Strawn, Coffey County, Kansas.

Repository of specimen.—Indiana University Paleontologic Collections; specimen 5489, slides 5489 T1–T9; 5489 L1–L7.

Genus Dybowskiella
Waagen & Wentzen, 1886

The genus *Dybowskiella* was erected by Waagen & Wentzel (1886, p. 916–919) who asserted that it differs from the genus *Fistulipora* only in having two strongly projecting septa which extend the length of the zooecia. Waagen & Wentzel (1886, p. 917) clearly state: " . . . *Dybowskiella* is in

TABLE 2.—MEASUREMENTS OF *Cyclotrypa* CF. *C. Abdita*

Text-figure 1 shows locations of sections; figure in ( ) indicates number of measurements. (Section T9 of Text-fig. 1 not measured because of poor orientation.)

Section	Maximum zooecial diameter in mm.	Interzooecial distance in mm.	Number of zooecia in 4 mm.^{2} area
5489 T1	Average 0.38 Range 0.26–0.44 (10)	Average 0.21 Range 0.11–0.33 (18)	46, 44, 47
5489 T2	Average 0.42 Range 0.39–0.46 (10)	Average 0.18 Range 0.06–0.29 (17)	46, 44, 44
5489 T3	Average 0.41 Range 0.35–0.51 (10)	Average 0.21 Range 0.09–0.36 (20)	45, 46, 40
5489 T4	Average 0.42 Range 0.34–0.45 (10)	Average 0.22 Range 0.13–0.36 (16)	43, 43, 35
5489 T5	Average 0.44 Range 0.39–0.47 (10)	Average 0.22 Range 0.11–0.35 (17)	36, 32, 38
5489 T6	Average 0.42 Range 0.33–0.51 (10)	Average 0.21 Range 0.08–0.42 (17)	41, 42, 43
5489 T7	Average 0.43 Range 0.39–0.46 (10)	Average 0.21 Range 0.09–0.38 (17)	41, 32, 37
5489 T8	Average 0.42 Range 0.37–0.46 (10)	Average 0.22 Range 0.11–0.36 (18)	35, 36, 35

all respects identical with *Fistulipora*, except in the existence of these septa. . .". The "septa" are actually extremities (pseudoœcepta) of the lunarium which project into the zooecium. These structures ("septa") are observed in tangential and longitudinal sections; in the latter they appear, in appropriately oriented sections, as two thin dark lines within the zooecium, each line paralleling the length of the zooecium and a short distance removed from the zooecial wall. Bassler (1953, p. G85) indicates that this genus is known only from Permian rocks, but Crockford (1957, p. 15) states that the genus is known from Lower Carboniferous rocks of eastern Australia and may questionably be found in Devonian strata.

American authors have generally regarded *Dybowskiella* as a synonym of *Fistulipora*. This viewpoint has been held by Nickles & Bassler (1900, p. 266) and Bassler (1934, p. 113); Simpson (1895, p. 559) considered *Dybowskiella* as a synonym of *Lichenalia*. More recently, Bassler (1953, p. G84) accepted *Dybowskiella* as a valid genus.

American paleontologists have not hitherto assigned any fistuliporoids from North America to *Dybowskiella*; however, bryozoans possessing the generic characters of *Dybowskiella* are described in the literature. For example, the Niagaran species *Fistulipora crustula* Bassler (1906, p. 24) may possibly be more properly assigned to *Dybowskiella* as may several species described by Moore & Dudley (1944, p. 229–408) from Pennsylvanian and Permian strata of Kansas and other areas of western North America. Moore & Dudley assigned their specimens to the genus *Triphyllotrypa*

(Moore & Dudley, 1944, p. 291), which Bassler (1953, p. G85) and the authors regard as a synonym of *Dybowskiella*.

The writers are not certain of the relationship between *Dybowskiella* and *Fistuliporella* (Simpson, 1895, p. 560). *Fistuliporella* has the extremities of the lunarium projecting prominently into the zooecium, thereby resembling *Dybowskiella*, but presumably differs from *Dybowskiella* in surficial zoarial features.

Waagen & Wentzel (1886, p. 919) clearly state that transitional forms probably exist between *Dybowskiella* and *Fistulipora*. The present authors also point out that transitional forms certainly are known between *Cyclotrypa*, in which the lunarium is obsolete and indistinct, and *Fistulipora*, in which the lunarium may be well developed but does not have extremities that enter the zooecial tube. Assignment of structurally intermediate specimens to *Cyclotrypa* or *Fistulipora* or to *Fistulipora* or *Dybowskiella* is largely a matter of personal philosophy.

Dybowskiella should now be considered to range from Middle Silurian to Permian.

Dybowskiella brownsportensis
Perry & Hattin, n. sp.
Pl. 131, figs. 1–6

Zoarium ramose, sparsely branched, as much as 2 inches in height and somewhat over 0.5 inch in diameter. Lunaria plainly visible, but maculae very indistinct and presumably of irregular distribution.

In tangential section, zooecia irregularly spaced, thin-walled, and irregularly to broadly pyriform; most typically 4 entire zooecia in 2 mm., commonly a portion of 5th zooecium in this distance, and less commonly 5 entire zooecia in 2 mm.; rarely 3 entire zooecia and part of 4th zooecium in a 2-mm. distance; average zooecial diameter, including lunarium, 0.25 mm., ranging from 0.19 to 0.33 mm., with only 1 of 20 measurements less than 0.21 mm. and 1 exceeding 0.30 mm. Lunarium prominent, commonly forming one-third of zooecial diameter, typically not thickened, and conspicuously indenting zooecial cavity; prominence of lunarium and its conspicuous indentation of zooecial tube impart trilobed appearance to many zooecia. Vesicles irregularly polygonal, ranging from less than one-half size of zooecium to nearly twice the size of an average zooecium, typically 1 vesicle, less commonly 2, between adjacent zooecia; interzooecial distance averages 0.21 mm., ranging from 0.06 to 0.32 mm. for 26 measurements. Maculae nearly 2 mm. in diameter and typically formed of mosaic of large irregularly polygonal vesicles.

In transverse section, zooecia similar in appearance to those of tangential section; typically 4 entire zooecia in 2 mm., this distance commonly including part of 5th zooecium; rarely 5 entire zooecia in 2 mm.; zooecial diameter, including lunarium, averages 0.24 mm., ranging from 0.19 to 0.29 mm. for 20 measurements of which only 5 deviate from the stated average by more than 0.03 mm. Lunarium prominent, commonly occupying as much as one-half of the zooecial diameter, nonthickened, and conspicuously indenting zooecial cavity; zooecia trilobed in appearance because of conspicuous indentation of zooecial tubes by lunaria. Vesicles large, irregularly polygonal, typically 1 between adjacent zooecia; interzooecial distance averages 0.19 mm. ranging from 0.10 to 0.26 mm. for 21 measurements.

In longitudinal section, zooecia thin-walled throughout length, parallel to length of zoarium in axis, gradually bending to intersect surface of zoarium at nearly right angles. Diaphragms thin, horizontal or mildly concave upward, virtually lacking in axis and sparsely developed in remainder of zoarium. Appropriately oriented zooecia show two thin continuous dark lines, one near each zooecial margin, that are cut ends of extremities of lunarium that extends into the zooecial tube. Vesicles generally crescentic, convex outward, and commonly forming mutually imbricating or interlocking columns; vesicles generally thinner in outer part of zoarium than in axis where they are commonly coarser and more irregularly arranged. Axis commonly contains zones, each usually less than 0.7 mm. thick, of thin vesicles bordered proximally and distally by coarser vesicles; zones of thin vesicles presumably indicative of temporary adverse conditions resulting in in retardation of colony growth.

Remarks.—This species is the first described Silurian fistuliporoid that has been assigned to *Dybowskiella*. The most striking

structural character of this species is the conspicuous nonthickened lunarium which prominently indents the zooecial tube, thereby imparting a trilobed appearance to many zooecia.

The specific name was selected to reflect its stratigraphic occurrence in the Brownsport formation of western Tennessee.

Although the foregoing description is based on the holotype and three paratypes used specifically in this study, the senior author examined thin sections of more than 100 specimens of *D. brownsportensis* and measured maximum zooecial diameter and interzooecial distance in 25 typical specimens; the measurements were made on conventionally oriented tangential sections. In order that the structural variability of this species can be better appreciated, measurements of the 25 typical specimens follow: maximum zooecial diameter (based on 126 measurements) averages 0.28 mm., ranging from 0.19 to 0.35 mm.; and interzooecial distance (based on 226 measurements) averages 0.19 mm. ranging from 0.06 to 0.35 mm.

Examination of Table 3 demonstrates clearly that the maximum zooecial diameter, as measured in transverse section, does not exceed the limits of this character as determined in 25 tangential sections. The greatest deviation from the average maximum zooecial diameter in tangential and transverse sections of each of the four specimens considered in Table 3 does not exceed 0.03 mm. Table 3 also illustrates that the range in interzooecial distance, as measured in transverse section, does not exceed the variability range of this character in tangential section. The four specimens analyzed in Table 3 show deviation of average interzooecial distance in transverse and tangential sections within the same specimen of not more than 0.03 mm. Plate 131, figures 1,2,5 reveals that form and prominence of lunarium are essentially the same in tangential and transverse sections. The authors conclude that maximum zooecial diameter, interzooecial distance, and form and prominence of the lunarium did not change during astogeny in excess of the limits of specific variability of these characters.

Occurrence.—This species abounds at many exposures of the Brownsport formation in western Tennessee.

Types.—Indiana University Paleontologic Collections; holotype specimen and slides 5490; paratype specimens and slides 5491–5493.

DISCUSSION OF RESULTS

1. Internal structures and characters commonly used in differentiating fistuliporoid species remain relatively constant throughout the zoarium as shown in Tables 1–3. Without exception, however, the average maximum zooecial diameter of the four

TABLE 3.—MEASUREMENTS IN MM. OF *D. brownsportensis*

Maximum zooecial diameter includes lunarium; figure in ( ) indicates number of measurements. Holotype is specimen 5490.

Specimen	Maximum zooecial diameter, tangential section	Maximum zooecial diameter, transverse section	Interzooecial distance, tangential section	Interzooecial distance, transverse section
5493	Average 0.26 Range 0.21–0.29 (5)	Average 0.24 Range 0.20–0.26 (5)	Average 0.21 Range 0.12–0.28 (5)	Average 0.19 Range 0.12–0.26 (5)
5490	Average 0.26 Range 0.23–0.29 (5)	Average 0.25 Range 0.22–0.28 (5)	Average 0.24 Range 0.18–0.32 (5)	Average 0.21 Range 0.11–0.26 (5)
5492	Average 0.27 Range 0.22–0.33 (5)	Average 0.24 Range 0.20–0.29 (5)	Average 0.18 Range 0.11–0.25 (8)	Average 0.18 Range 0.10–0.24 (5)
5491	Average 0.22 Range 0.19–0.24 (5)	Average 0.23 Range 0.19–0.25 (5)	Average 0.15 Range 0.06–0.25 (7)	Average 0.17 Range 0.10–0.26 (5)

specimens of *Fistulipora hemisphaerica* (Roemer) decreases with increasing depth from the surface of the zoarium; three of the four specimens of *Dybowskiella brownsportensis* n. sp. show the same trend, as is revealed by examination of tangential and transverse sections. In contrast, the average maximum zooecial diameter in *Cyclotrypa* cf. *C. abdita* Moore & Dudley increases somewhat toward the base of the colony. Within the limits of specific variability, the distance between adjacent zooecia remained constant during the development of the colony. The prominence and other characters of the lunarium did not change detectably during astogeny.

The development of the *Dybowskiella* zoaria ramose contrasts greatly with zoaria of trepostomatous bryozoans. Boardman (1954, p. 322,323) has pointed out that structures of specific character in trepostomes show such wide variation within the zoarium that as many as three "species" may be recognized within the same colony.

2. Some authors have contended that the nature of the vesicular (interzooecial) tissue, as observed in longitudinal section, is of importance in differentiating species of fistuliporoids. We reiterate our belief (Perry & Hattin, 1955, p. 1695,1696) that the structural variability of vesicular tissue within a single zoarium, as revealed by longitudinal sections, is too great for use in specific differentiation. In general, vesicles in *Dybowskiella brownsportensis* are larger and coarser in the axis than near the surface of the zoarium where vesicles usually are smaller and thinner. In almost all specimens of fistuliporoids examined by the authors, a single zoarium shows, in longitudinal section, vesicles that vary greatly in size and in their arrangement with respect to one another.

3. The authors presume that the growth of the colony did not proceed uniformly. Zones of thin vesicles are interpreted to reflect periods when somewhat adverse environmental conditions retarded growth in these stages of colonial development; such zones, generally less than 0.75 mm. thick and flanked proximally and distally by larger vesicles, may extend completely through the zoarium or may grade laterally and imperceptibly into more normal vesicular tissue. The local nature of some zones of thin vesicles can probably be explained by sediment impinging on a small area of the colony, thereby causing temporary and localized growth restriction. Diaphragms may be somewhat more closely spaced at horizons of thin vesicles.

A similar response to environmental conditions is revealed by variations in structures of stromatoporoids (Galloway & St. Jean, Jr., 1957, p. 69). In stromatoporoids, thin latilaminae, composed of zones of closely spaced laminae, reflect adverse growth conditions, whereas thick latilaminae, usually composed of zones of widely spaced laminae, presumably indicate optimum growth conditions.

4. The phyletic relationship of *Dybowskiella*, *Fistulipora*, and *Cyclotrypa* cannot be ascertained from this study. If *Dybowskiella* had been derived from *Fistulipora*, then one might expectably find *Fistulipora*-type lunaria in the early formed portion of the zoarium of *Dybowskiella;* such was not observed. Similarly, if *Cyclotrypa* had developed from *Fistulipora* by degeneration or atrophy of the lunarium, then one might expectably note increasing prominence of the lunarium toward the base or early formed portion of the *Cyclotrypa* zoarium; such was not noted. The authors consider that this study does not invalidate the law of recapitulation in any way because, if these genera are related phyletically, such relationship could be indicated in the unobserved protoecium or ancestrula developmental stage.

5. Results of this study should not be extrapolated to embrace all cyclostomatous bryozoans nor necessarily all fistuliporoids. Specimens of *Fistulipora hemisphaerica* (Roemer) and *Dybowskiella brownsportensis* n. sp. were selected for this study because they are very typical representatives of their respective populations. The senior author has sectioned more than 100 representatives of each of these species in connection with his study of the bryozoan fauna of the Brownsport formation.

REFERENCES

AMSDEN, T. W., 1949, Stratigraphy and paleontology of the Brownsport formation (Silurian) of western Tennessee: Peabody Mus. Nat.

Hist., Bull. 5, 138 p., 34 pls., 30 figs., New Haven, Yale Univ. Press.

BASSLER, R. S., 1906, The bryozoan fauna of the Rochester shale: U. S. Geol. Survey, Bull. 292, 137 p., 31 pls.

——, 1915, Bibliographic index of American Ordovician and Silurian fossils: Smithsonian Inst., U. S. Nat. Mus., Bull. 92, v. 1, 718 p.

——, 1934, Bryozoa, *in* Fossilium Catalogus I: Animalia, W. QUENSTEDT, editor, pars 67, Bryozoa: 229 p., 's-Gravenhage, W. Junk.

——, 1953, Bryozoa, *in* Treatise on Invertebrate Paleontology, R. C. MOORE, editor, Part G, Bryozoa: 253 p., 175 figs., Lawrence, Kansas, Univ. Kansas Press and Geol. Soc. America.

BOARDMAN, R. S., 1954, Morphologic variation and mode of growth of Devonian trepostomatous Bryozoa: Science, new ser., v. 120, p. 322, 323.

CROCKFORD, JOAN, 1957, Permian Bryozoa from the Fitzroy basin, Western Australia: Commonwealth of Australia, Dept. National Development, Bureau of Mineral Resources, Geol. and Geophysics, Bull. 34, 136 p., 21 pls.

CUMINGS, E. R., 1904, Development of some Paleozoic Bryozoa: Am. Jour. Sci., 4th ser., v. 17, p. 49–78.

——, 1905, Development of *Fenestella:* Am. Jour. Sci., 4th ser., v. 20, p. 169–177, 3 pls.

GALLOWAY, J. J., & ST. JEAN, JOSEPH, JR., 1957, Middle Devonian Stromatoporoidea of Indiana, Kentucky, and Ohio: Bull. Am. Paleont., v. 37, no. 162, 308 p., 23 pls.

LEE, G. W., 1912, The British Carboniferous Trepostomata: Mem. Geol. Survey Gt. Brit., v. 1, pt. 3, p. 135–195, pls. 14–16.

MOORE, R. C., & DUDLEY, R. M., 1944, Cheilotrypid bryozoans from Pennsylvanian and Permian rocks of the midcontinent region: Kans. Geol. Survey, Bull. 52, pt. 6, p. 229–408, 48 pls.

NICKLES, J. M., & BASSLER, R. S., 1900, A synopsis of American fossil Bryozoa including bibliography and synonymy: U. S. Geol. Survey, Bull. 173, 663 p.

PERRY, T. G., & HATTIN, D. E., 1955, Osgood (Niagaran) bryozoans from the type area: Geol. Soc. America Bull., v. 66, no. 12, p. 1695, 1696 (Abs.).

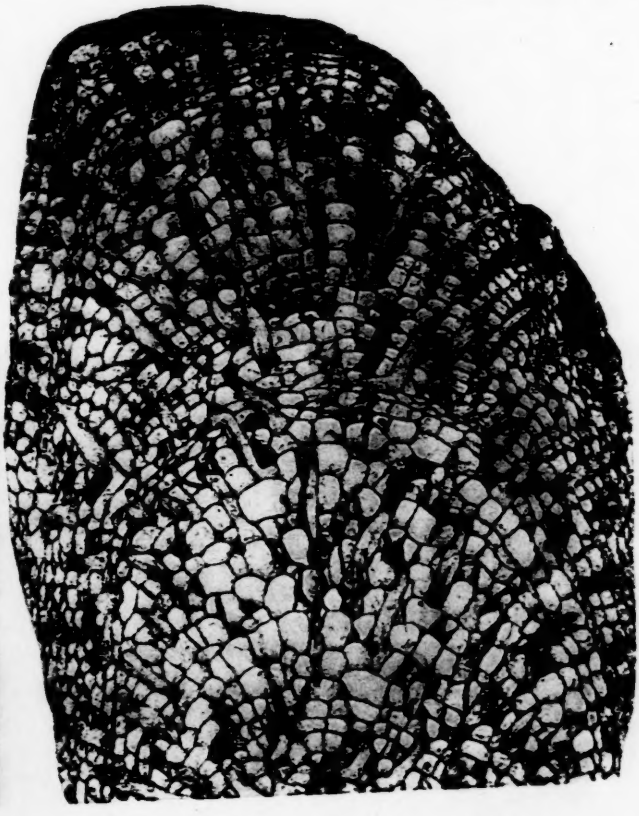
ROEMER, FERDINAND, 1860, Die silurische Fauna des westlichen Tennessee: 100 p., 5 pls., Breslau, Verlag von Eduard Trewendt.

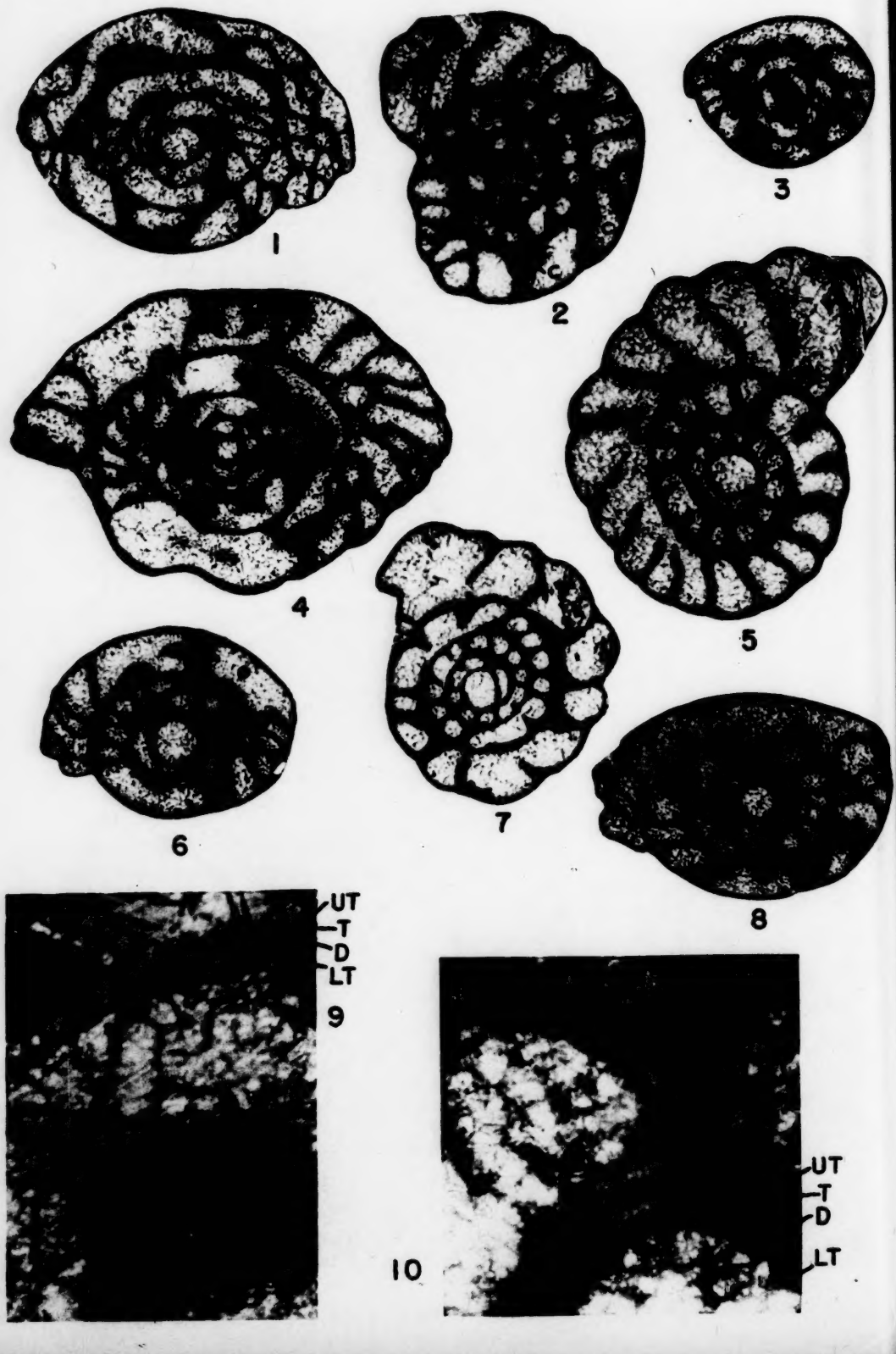
SIMPSON, G. B., 1895, A handbook of the genera of the North American Paleozoic Bryozoa: N. Y. State Geol. Ann. Rept. 14, p. 407–669, pls. A–E, 1–25.

WAAGEN, WILLIAM, & WENTZEL, JOSEPH, 1886, Salt-Range fossils: Palaeont. Indica, ser. 13, v. 1, pt. 6, 854–892, 904–924, pls. 102–115.

EXPLANATION OF PLATE 131

FIGS. *1–6—Dybowskiella brownsportensis* n. sp. Holotype (Ind. Univ. Paleont. Coll. 5490) and paratype (Ind. Univ. Paleont. Coll. 5492) from the Brownsport formation (Niagaran) south of Hall School, Perry County, Tennessee. Holotype figures: *1*, tangential section, ×20; *2*, transverse section, ×20; *3*, longitudinal section, ×20; *4*, longitudinal section showing cut extremities of lunarium, ×60. Paratype figures: *5*, tangential section showing lunaria extending into zooecia, ×60; *6*, longitudinal section, ×12.




1
2
3
4
5
6
7
8
UT
T
D
LT
9
UT
T
D
LT
10

JOURNAL OF PALEONTOLOGY, V. 32, NO. 6, P. 1051–1070, PLS. 132–137, 2 TEXT-FIGS., NOVEMBER 1958

SOME FUSULINIDS FROM THE UPPER STRAWN, PENNSYLVANIAN, OF TEXAS

WENDELL J. STEWART
The Texas Company, Fort Worth, Texas

ABSTRACT—The new genera and species *Plectofusulina franklinensis* and *Frumentella exempla* with the new species *Fusulina vintonensis* are described from the upper Magdalena formation in the Franklin Mountains, El Paso County, Texas. The new species *Paramillerella dogbendensis*, *Fusiella texana*, *Fusulina whitakeri*, *F. brazosensis*, *F. valida*, *F. bellatula*, *F. gordonensis* and *F. cappsensis* are from the Capps, East Mountain Shale, and Garner formations of the upper Strawn exposed along the Colorado and Brazos river drainage areas of Palo Pinto, Eastland and Brown Counties, Texas.

The new species *Fusiella texana* was found stratigraphically higher than the most advanced forms of *Fusulina* and is the first true recognition of this genus in America.

These fusulinids occur above the recognized zone of *Wedekindellina* and below the zone of *Triticites* in Texas and are considered to be upper Strawn.

INTRODUCTION AND ACKNOWLEDGMENTS

THE fusulinid species described here occur above the continuous zone of the genus *Wedekindellina* and below the zone of *Triticites* in Texas and are characteristic of upper Strawn (Des Moines) fusulinid fauna. Most of the species of *Fusulina* exhibit advanced characteristics for the genus, such as: thin spirotheca with a thick diaphanotheca, intensely and erratically fluted septa, and *pseudochomata* formed by secondary deposits around partly absorbed septal loops. These *pseudochomata* are not true ridges and rarely show a layered structure found in earlier forms of the genus in lower Strawn rocks of Texas. The chomata are indistinct or absent in the mature stages of the majority of the species of *Fusulina* described in this paper.

Fusiella texana, n. sp., is the only species of this genus recognized in America and has been collected from only one locality in Texas. Therefore, the range of this genus or species is unkown. Several poor specimens plus the holotype were collected from the Dog Bend limestone member of the Salesville formation at locality T-S-908 in Palo Pinto County, Texas. The genus *Fusulina* has not been found above the East Mountain shale formation in this area, nor has the genus *Triticites* been found below the Keechi Creek formation. It appears, therefore, that *Fusiella* occurs between the limits of these two genera (Text-fig. 2). In Russia, *Fusiella* occurs with *Fusulina cylindrica*, one of the most advanced forms of *Fusulina*, in the Mjatschkowa limestone near Moscow. Also in China *Fusiella* is found with this advanced species of *Fusulina* in the Huanglung limestone of Kwanshan, Lungtan (Lee & Chen, 1930). The writer has identified the genus *Fusiella* from rock specimens collected by Japanese workers from the Middle Carboniferous, Gifu, Fukuchi, Japan, where it occurs with *Millerella* sp., *Pseudostaffella quadrata*, *Eoschubertella* sp., and *Fusulina* cf. *F. ohtanii*. Thompson and Thomas, 1953, described a single specimen from the Casper

EXPLANATION OF PLATE 132

All specimens illustrated on this plate are from the Bishops Cap limestone member of the Magdalena formation exposed in Vinton Canyon, Franklin Mountains, Texas.

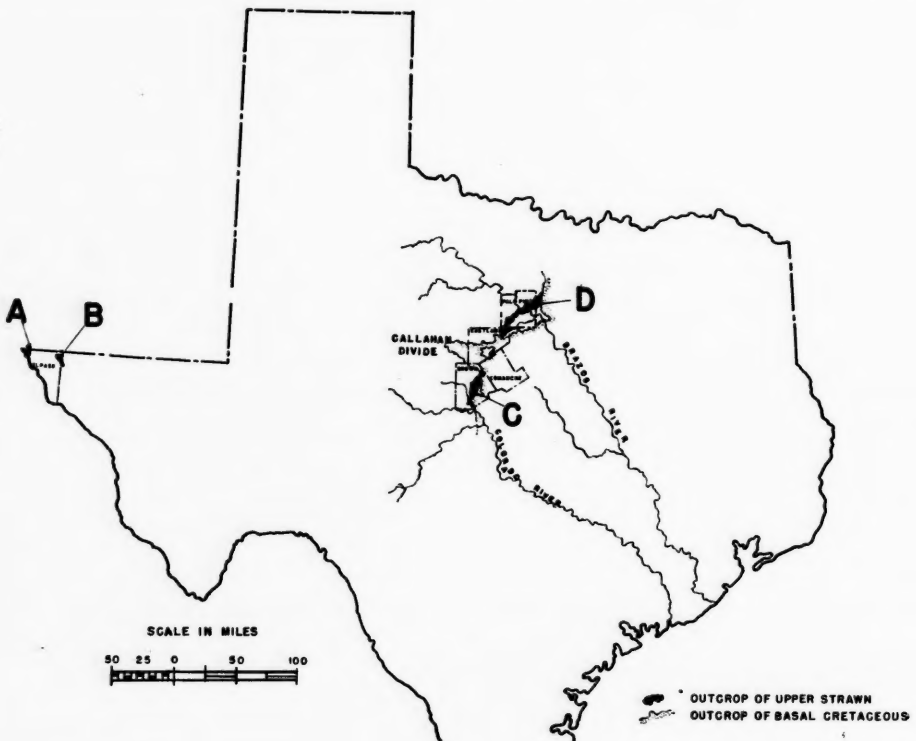
FIGS. *1–10*—*Plectofusulina franklinensis* Stewart, n. gen., n. sp. *1*, Axial section of the holotype, ×70; *2,5,7*, sagittal sections of paratypes, C=chomata, ×70; *3*, tangential section of paratype illustrating twisted type of coiling, ×70; *4,6,8*, axial sections of paratypes, ×70; and *9,10*, enlarged detail of wall of paratypes *4* and *5*, respectively, UT=upper tectorium, T=tectum, D=diaphanotheca, and LT=lower tectorium, ×600.

formation, Deadhead Basin, Wyoming, as *Schubertella* sp. but remarked that in certain respects it was difficult to distinguish from *Fusiella typica*. Their form is described from a locality where it is associated with a minute *Triticites*, and from the illustration it appears quite similar to the species described here. However, the well preserved wall structure is described with a clear lower layer in the spirotheca, as exhibited by *Schubertella*, which would make this form easily distinguishable from *Fusiella*.

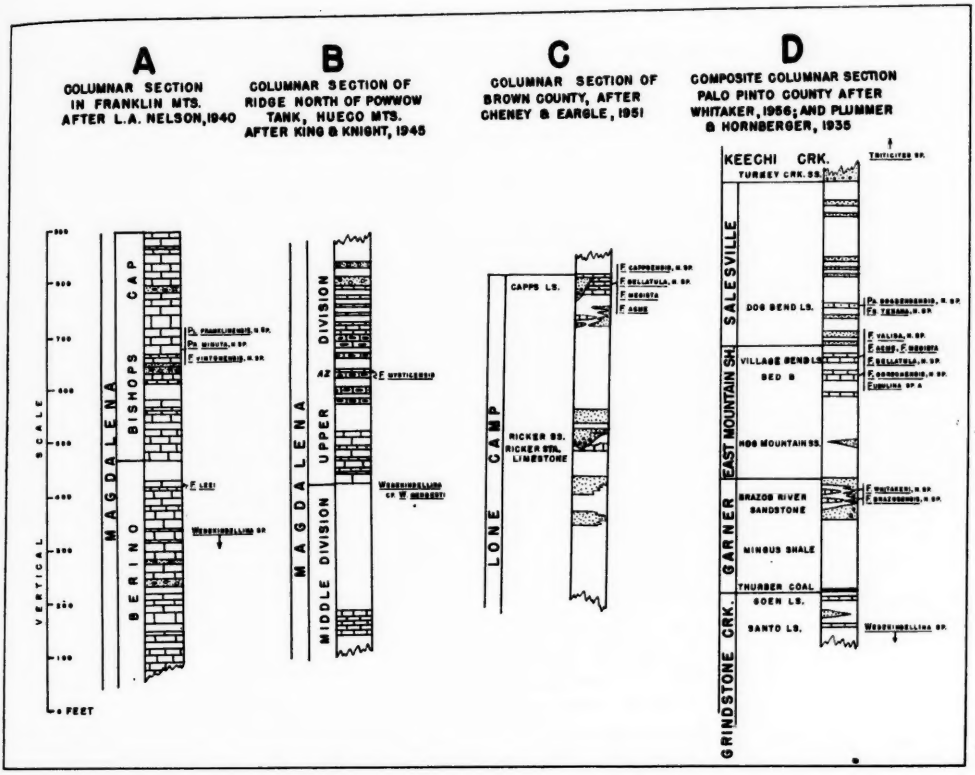
The writer wishes to thank The Texas Company for permission to publish this paper and for the use of facilities that made the work possible. Special thanks are due Mr. Doyle G. Whitaker of Midland, Texas, who collected and furnished many of the specimens studied from Palo Pinto County. Texas Christian University kindly made available the specimens collected by Mr. Whitaker in connection with his Master of Arts thesis.

STRATIGRAPHIC CONSIDERATIONS

Four areas in Texas where known upper Strawn rocks crop out are shown on the accompanying illustration (Text-fig. 1). The term upper Strawn as used in this paper does not designate a stratigraphic unit of rocks, but is defined as that section occurring above the zone of *Wedekindellina* and within the zone of *Fusulina*. The genera *Fusiella* and *Paramillerella* are included in this paper because of their occurrence with *Fusulina* in Russia, China, and Japan. The species *Fusulina leei* is included because it is found to occur above the highest form of *Wede-*



TEXT-FIG. 1—Index map of Texas, showing counties where upper Strawn rocks outcrop; A, B, C, and D indicate areas of compiled columnar sections.



TEXT-FIG. *2*—Measured columnar sections from four main areas of outcrop of the upper Strawn shown on the index map of Texas (Text-fig. *1*). The highest stratigraphic position of *Wedekindellina* known is noted at the right of each column where the position of the other fusulinids described in this paper are also shown.

kindellina collected from the Magdalena formation of the Franklin Mountains, Texas.

The area of upper Strawn north of the Callahan Divide, shown on the map (Text-fig. 1), is exposed in the drainage system of the Brazos River, while the area south of the divide is exposed in that of the Colorado River. Between these two localities, the upper Strawn is concealed by sediments of lower Cretaceous age, which form the topographic divide. The stratigraphic units of the upper Strawn to the south cannot be traced through this cover to those exposed north of the divide, yet the two sections are similar in age as shown by the many species of *Fusulina* found common to both. No attempt has been made in this work to correlate any of the stratigraphic members of the upper Strawn of Texas due to the incomplete collections of the fusulinid fauna and the lack of knowledge on the part of the author of all the field relationships.

COLLECTION LOCALITIES

T-S-201 Cappa limestone; exposed in road cut along U. S. Highway 84, 1.25 miles east of junction of U. S. Highway 84 and 67, northeast corner of R. Highsmith survey, east-northeast of Brownwood, Brown County, Texas.

T-S-260 Capps limestone; exposed in road cut along U. S. Highway 84, 0.5 miles east from junction with U. S. Highway 67; ¼ mile east of Early School; east-northeast of Brownwood, Brown County, Texas.

T-807 Capps limestones; exposed on small knoll and in road cut along U. S. Highway 67, 100 yards northwest of Jones Chapel Baptist Church, two miles northeast of junction of U. S. Highways 84 and 67, approximately five

miles northeast of Brownwood, Brown County, Texas.

T-808 Capps limestone; exposed in road cut at crossing of farm roads ¾ mile west of locality T-S-807, ½ mile west of junction of farm road with U. S. Highway 67, Brown County, Texas.

T-S-254 Capps? or Village Bend limestone; 100 yards west of Texas State Highway 6, southern edge of city limits of Gormon, Texas, just north of Comanche County line, 300 feet north of Roxana No. 1 Rudd Well.

T-S-760 Village Bend limestone; nodular limestone exposed 100 yards northwest of junction of U. S. Highway 80 with State Highway 16, 10.5 miles east of Ranger, Eastland County, Texas.

T-S-910 Brazos River Sandstone; exposed in cliff along U. S. Highway 80, 70 yards south of highway, ¼ mile east of bridge over small tributary of Bear Creek, 0.3 mile west of Desdemona Cut-off, and about 11 miles east of Ranger, Eastland County, Texas.

T-S-887 Village Bend limestone; exposed in road cut through hill along farm road 919, one mile due west of large cattle tank, 5.5 miles north of Gordon, Palo Pinto County, Texas.

T-S-907 Village Bend limestone; exposed in ridge, ¼ mile north of low water bridge on Gordone-Lone Camp road, three miles west of Lone Camp, Palo Pinto County, Texas.

T-S-908 Massive limestone immediately below Village Bend limestone, one mile north of low water bridge of locality T-S-907, across saddle in ridge; exposed along the north side of small creek.

T-S-909 Thin limestone lentils 20 feet above the lower of two sandstones, Brazos River sandstone; ¼ mile south of low water bridge of locality T-S-907, on west side of small tributary of Palo Pinto Creek. *A* designates the upper and *B* the lower of the two limestone lentils.

T-S-802 Magdalena formation, bed 118, L. A. Nelson, 1940, Bishops Cap member; ¼ mile west and south of end of road leading into Vinton Canyon, steeply dipping beds immediately above and west of small quarry, about 5.5 miles east of Vinton, Texas, on U. S. Highway 80; Franklin Mountains, Texas.

T-S-803 Locality same as T-S-802; collection from bed 98, L. A. Nelson, 1940.

T-S-433G Magdalena limestone; ridge north of Powwow Tank, Powwow Canyon, Hueco Mountains, Texas. Locality same as column 14, bed AZ, P. B. King & J. B. Knight, 1945.

SYSTEMATIC DESCRIPTIONS

Family FUSULINIDAE Möller
Subfamily OZAWAINELLINAE Thompson & Foster
Genus PARAMILLERELLA Thompson
PARAMILLERELLA DOGBENDENSIS Stewart, n. sp.
Pl. 137, figs. 12 & 13

The test is minute and is planispiral in all volutions; with a straight axis of coiling, subdiscoidal shape, and subangular to slightly rounded periphery. The first one to one and a half volutions are slightly evolute, the remaining two or three volutions are slightly involute. The large specimens of four and five volutions measure up to 0.20 mm. in axial length and 0.50 mm. in width, with a mean form ratio of 1:2.5.

The septa are thin and curve slightly toward the anterior, with a very small degree of fluting. In most sagittal sections, the septa extend downward to the preceding volution, with faint evidence of a tunnel. Septal counts for the first to the third volution give 10–12, 14–16, and 15–18, respectively.

The spirotheca is relatively thick compared to other species of this genus and is composed of a tectum covered above and below by thick tectoria. The proloculus is minute, with an average outside diameter of 50 microns. The expansion of the shell is uniform with the heights of volutions measuring 28, 40, 76 and 86 microns, respectively. The tunnel is narrow and straight, bordered by low, symmetrical, indistinct chomata.

Remarks.—This specifies differs from *Paramillerella advena* (Thompson) and *P. ampla* (Thompson) by having a much smaller form ratio, larger proloculus, and a thicker spirotheca.

Paramillerella dogbendensis, n. sp., is distinguished from *Millerella* by the smaller form ratio, involute mature stages, and the lack of flaring in the last stages of growth.

The genus *Eostaffella* Rauser, 1948, was not considered here since many forms have been referred to it, including *Millerella marblensis*. Its generic characteristics are not yet clearly understood. *Eostaffella* would have priority over *Paramillerella* if they prove to be congeneric.

Occurrence.—This species is scarce throughout most of the East Mountain shale and in the lower part of the Salesville formations exposed along the ridge a half mile north of the Lone Camp-Gordon road, 3.6 miles southwest of Lone Camp, Palo Pinto County, Texas. The type species is from the Dog Bend limestone member about 45 feet above the base of the Salesville formation (T-S-908).

Type.—Bureau of Economic Geology,

University of Texas, Catalogue no. BEG 20481.

Subfamily SCHUBERTELLINAE Skinner
Genus FUSIELLA Lee & Chen
FUSIELLA TEXANA
Stewart, n. sp.
Pl. 137, figs. 14 & 15

The shell is small and subovate in early stages to fusiform in the last two or three volutions. The whorls are tightly coiled, with an endothyroid juvenarium and with the first two volutions at right angles to the axis of coiling of the last three. The septa are slightly folded, exhibiting indistinct markings in the central area that become more discernible loops in the axial extremities.

The average length is 0.66 mm. and the width is 0.27 mm. giving a form ratio of 1:2.5. The proloculus averages 40 microns in outside measurements. The heights of the third, fourth, and fifth volutions are 27, 31 and 43 microns, respectively.

The thin spirotheca is composed of three layers; a tectum or middle primary layer, a lower primary layer and an upper secondary layer. The wall varies considerably in thickness throughout the test. The tunnel is wide and irregular and is bordered by low asymmetrical chomata which extend toward the axial extremes. The axis of the mature fusiform volutions curves slightly in the extremes where a slight amount of secondary filling is present.

Remarks.—This species differs from *F. typica* Lee & Chen by its smaller size, larger proloculus, less fusiform younger whorls, and better defined endothyroid juvenarium.

Occurrence.—*Fusiella texana* was collected from the Dog Bend limestone by Mr. D. G. Whitaker, The Texas Company, Midland, Texas. The locality is 3.6 miles southwest of Lone Camp, Texas, along the Gordon road; the exposure is near the top of the ridge about a half mile north of cement culvert on the road. They are extremely rare and only a few specimens were studied. (T-S-908).

Type.—Bureau of Economic Geology, University of Texas, Catalogue no. BEG 20482.

Genus FRUMENTELLA Stewart, n. gen.
Type species: FRUMENTELLA EXEMPLA Stewart, n. sp.

The name *Frumentella*, meaning small grain in Latin, is here proposed for a new minute fusiform fusulinid genus from the Franklin Mountains of Texas. The spirotheca of this genus is composed of three layers: an upper epithecal layer or tectorium and two prothecal layers of a tectum and lower layer. The proloculus is large in proportion to the overall shell size. The axis of coiling of the juvenarium is at large angles to the axes of the mature volutions. The chomata extend toward the axial regions and blend in with deposits of secondary fill-

TABLE 1.—MEASUREMENTS OF *Frumantella exempla*, N. SP., IN MILLIMETERS

Volution	Half Length				Radius Vector				Form Ratio			
	1	2	3	4	1	2	3	4	1	2	2	4
0	.050	.045	.050	.040	.050	.040	.045	.037	—	—	—	—
1	.205	.070	.095	.060	.080	.055	.055	.055	2.5	1.3	1.7	1.1
2	.370	.158	.200	.240	.135	.095	.095	.100	2.7	1.7	2.1	2.4
3	.595	.340	.430	.375	.200	.145	.140	.155	3.0	2.4	3.0	2.4
4		.510	.575			.210	.210			2.4	2.7	

	Tunnel Angle (degrees)				Wall Thickness				Septal Count			
	1	2	3	4	1	2	3	4	1	2	3	4
1	22°	21°	16°		.010	.009	.009	.008				
2	22°	16°	27°		.009	.011	.011	.010	6	8	7	
3	26°	31°	31°		.009	.012	.011	.012	12	14	14	
4	23°				.009	.013	.013	.011	16	18	17	
5						.012	.012					

ing in these areas. There is a marked absence of septal fluting.

The collective characteristics given above seem to separate this genus from any other previously described. *Frumentella* is here included with the forms grouped under the subfamily Schubertellinae because of the three layered wall, small size, and erratically coiled juvenarium. However, it has some of the features of the more advanced genera of the subfamily Fusulininae and may be transitional. It differs from the genus *Schubertella* of the first group by having a three layered wall, large proloculus, and axial fill. It differs from *Wedekindellina* of the latter group by the development of a three layered wall, erratically coiled juvenarium, and a very small size.

Frumentella exempla, n. sp., was originally grouped under the genus *Profusulinella* because of the similarity of the wall structure, but after discussing the genotype for this latter genus with M. L. Thompson and others, several differences are noted. *Profusulinella* does not have the flowing chomata, is much larger in size, has some broad septal fluting, and is inflated rather than elongate fusiform in shape.

At present the range of this genus is not known. It occurs with *Plectofusulina franklinensis*, n. sp., and *Fusulina vintonensis*, n. sp., in the Bishops Caps member of the Magdalena formation, which is here considered to be upper Strawn. In the subsurface of west Texas, this form has been found in rocks of both upper and lower Strawn age.

FRUMENTELLA EXEMPLA Stewart, n. sp.
Pl. 133, figs. 1–10

The test is minute and fusiform, with pointed to slightly rounded polar regions. The axis of coiling is slightly bent at its extremities. Only a few specimens could be oriented in a plane to show both polar extremities. Mature specimens of three to four volutions measure 0.90 to 1.14 mm. in length and 0.38 to 0.50 mm. in width, with an average form ratio of 1:2.5. The inner one to one and a half volutions are coiled at a different angle from the outer volutions. The expansion of the volutions is uniform in all but the last. Here, it expands slightly more distinctly. The heights of the volutions measure 25, 31, 54 and 80 microns, respectively. The subspherical proloculus is quite large in comparison to the overall size of the specimen, with an outside mean diameter of 90 microns.

The spirotheca is composed of three layers: the middle layer or tectum is a thick darker layer, the lower layer is uniform in thickness, and the upper layer varies in thickness throughout the length of the shell. The irregular tunnel angle ranges from 20° in the first volution to 31° in the third volution. It is flanked by heavy asymmetrical chomata. The chomata extend toward the axial extremes into deposits of secondary fill. These fillings increase in thickness poleward. The septa are unfluted except in the polar regions and are thinner than the spirotheca.

Remarks.—This form can be differentiated from *Parawedekindellina kamensis* Safonova (1951) of Russia by the three- instead of four-layered wall, larger form ratio, and smaller size. *Frumentella exempla*, n. sp., is similar in size to *Profusulinella mutabilis* Safonova, but may be distinguished by its larger proloculus, secondary fill, and form ratio.

Occurrence.—Collected from bed 118 of L. A. Nelson's measured section, Bishops Cap limestone member, of the Magdalena formation in Vinton Canyon of the Franklin Mountains, El Paso County, Texas. From steeply dipping beds above and immediately west of the edge of small quarry about $\frac{1}{4}$ mile west and $\frac{1}{4}$ mile south of the end of the road in canyon. (T-S-802).

Type.—Bureau of Economic Geology, University of Texas, Catalogue no. BEG 20483.

Subfamily FUSULININAE Möller
Genus PLECTOFUSULINA
Stewart, n. gen.
Type species: PLECTOFUSULINA FRANKLINENSIS Stewart, n. sp.

The new genus *Plectofusulina* is here established for a minute fusulinid discovered in great abundance in rocks of Strawn age in the Franklin Mountains, Texas. The test is minute in size, subglobular to ellipsoidal in shape and loosely coiled. It is character-

TABLE 2.—MEASUREMENTS OF *Plectofusulina franklinensis*, N. GEN., N. SP., IN MILLIMETERS

Volution	Half Length				Radius Vector				Form Ratio			
	1	2	3	4	1	2	3	4	1	2	3	4
0	0.045	0.057	0.045		0.041	0.056	0.043					
1	0.090	0.128	0.090		0.078	0.107	0.075		1.2	1.2	1.2	
2	0.144	0.217	0.173		0.128	0.203	0.130		1.1	1.1	1.3	
3	0.278	0.402	0.305		0.235	0.308	0.240		1.2	1.4	1.3	
4	0.515				0.372				1.4			

	Tunnel Angle (degrees)				Wall Thickness				Septal Count			
	1	2	3	4	1	2	3	4	1	2	3	4
1	12°	11°	14°	11°	0.012	0.013	0.013					
2	22°	16°	22°	24°	0.012	0.011	0.013		7	12	10	
3	26°	23°	28°	24°	0.011	0.016	0.012		12	15	15	
4					0.012	0.010	0.011		13	18	18	
5					0.010							

ized by the twisting of each volution about different axes of coiling. No two volutions seem to have the same axis of coiling with each varying at small angles vertically and horizontally to the preceding axis. This condition makes each specimen difficult to orientate for thin sectioning. Therefore, for uniformity, each specimen was ground in the plane parallel to that of the antitheca.

The proloculus is quite large for so small a fusulinid. The tunnel path is irregular. The chomata are dense, well developed, and symmetrical to asymmetrical. The spirotheca is composed of a tectum, diaphanotheca, and upper and lower tectoria and is thin and uniform in thickness. The fluting of the septa is slight across the central portion of each volution but increases in intensity in the polar regions. The excellent preservation of the specimens allowed detailed studies to be made of the wall, chomata, and septa.

Remarks.—This genus can be distinguished from other minute subglobular erratically coiled genera by its definite four-layered wall. *Eoschubertella lata* (Lee & Chen), 1927, revised by Thompson, 1937, is similar in size and coiling, but is described as having a three-layered wall composed of a tectum and upper and lower tectoria. *Plectofusulina*, n. gen. can also be distinguished from the Russian forms of *Schubertella* such as: *S. gracilis* Rauser-Cernoussova, 1951; *S. pauciseptata* var. *globulosa* Safonova, 1951, by the four-layered wall. The latter forms are described as having a tectum and diaphanotheca.

This new genus differs from *Fusulina* in its minute size, globose shape and erratic twisted coiling.

PLECTOFUSULINA FRANKLINENSIS
Stewart, n. sp.
Pl. 132, figs. 1–10

Test of *Plectofusulina franklinensis* is minute and subglobular to ellipsoidal, with a length of 0.70 to 1.00 mm. and a width of 0.50 to 0.70 mm., giving a form ratio of 1:1.1 to 1:1.4. The volutions are loosely coiled and uniform in height, measuring 40, 51,90 and 130 microns from the first to the fourth volution, respectively. There is a slight flare in the last few chambers of the last volution. The polar regions are well rounded. The fluting is slight in the central portion of the volution but is more intense in the polar regions.

The relatively large spherical proloculus averages 100 microns in external dimensions. The chomata are well developed and are symmetrical to asymmetrical. The tunnel angle averages 12° in the first volution, 21° in the second volution, and 25° in the last volution. The tunnel has an irregular path. The spirotheca is thin and uniform throughout the shell. It is composed of a tectum, diaphanotheca, and upper and lower tectoria. The twisted appearance is the re-

TABLE 3.—MEASUREMENTS OF *Fusulina acme* DUNBAR & HENBEST, IN MILLIMETERS

Volution	Half Length				Radius Vector				Form Ratio			
	1	2	3	4	1	2	3	4	1	2	3	4
0	0.090	0.090	0.094	0.090	0.089	0.089	0.090	0.090	—	—	—	—
1	0.290	0.225	0.211	0.185	0.125	0.115	0.115	0.125	2.2	1.9	1.8	1.6
2	0.500	0.430	0.452	0.370	0.185	0.160	0.180	0.175	2.6	2.7	2.5	2.1
3	0.825	0.685	1.070	0.625	0.265	0.245	0.280	0.265	3.1	2.8	3.8	2.3
4	1.23	1.032	1.373	1.000	0.380	0.345	0.405	0.385	3.2	3.7	3.4	2.6
5	2.156	1.525	1.763	1.802	0.545	0.480	0.595	0.570	3.9	3.2	2.9	3.1
6	2.818	2.002	2.262	2.387	0.745	0.655	0.805	0.800	3.8	3.1	2.8	3.0
7	3.588	2.741	3.214	3.126	0.980	0.910	1.020	1.045	3.7	3.0	3.2	3.0
8	4.158	3.696	—	4.004	1.210	1.125	—	1.190	3.4	3.3	—	3.4
9	4.589	3.850	—	—	1.385	1.335	—	—	3.3	3.0	—	—

	Tunnel Angle (degrees)				Wall Thickness				Septal Count			
	1	2	3	4	1	2	3	4	1	2	3	4
1	—	—	15°	13°	—	—	0.015	0.015				
2	20°	17°	17°	15°	0.015	0.015	0.015	0.015	12		14	15
3	15°	16°	16°	16°	0.030	0.025	0.025	0.025	16		21	19
4	21°	21°	20°	21°	0.035	0.035	0.035	0.030	23		23	25
5	27°	22°	21°	27°	0.045	0.030	0.030	0.035	29		27	29
6	30°	30°	31°	34°	0.035	0.035	0.035	0.035	36		36	35
7	33°	29°	30°	36°	0.040	0.040	0.040	0.040	35		—	35
8	36°	34°	—	43°	0.035	0.035	0.035	0.045	41		—	42
9	47°	45°	—	—	0.035	0.045	—	0.050	—			
10	—	—	—	—	0.040	0.035	—	—	—			

sult of variation of the axis direction for each volution, both vertically and horizontally. This is exhibited on Pl. 133, fig. 3, by chomata present in the sagittal section. In the normal coiling of average fusulinids, the chomata are seldom observed in a well orientated sagittal section.

Remarks.—This genus has been observed in cuttings from Strawn age rocks in the subsurface for several years, but the type species is the only one known occurrence from surface exposures.

Plectofusulina franklinensis is associated with *Frumentella exempla* n. sp., and *Fusulina vintonensis*, n. sp. From subsurface studies, the range of this genus is considered to be upper Strawn.

Occurrence.—The type specimens and from 118 of L. A. Nelson's measured section of the Magdalena formation, Bishops Cap member in Vinton Canyon, Franklin Mountains, El Paso County, Texas. From steeply dipping beds above and immediately west of the edge of small quarry about $\frac{1}{4}$ mile west and $\frac{1}{4}$ mile south of the end of the road in canyon. (T-S-802).

Types.—Bureau of Economic Geology, University of Texas Catalogue no. BEG 20484.

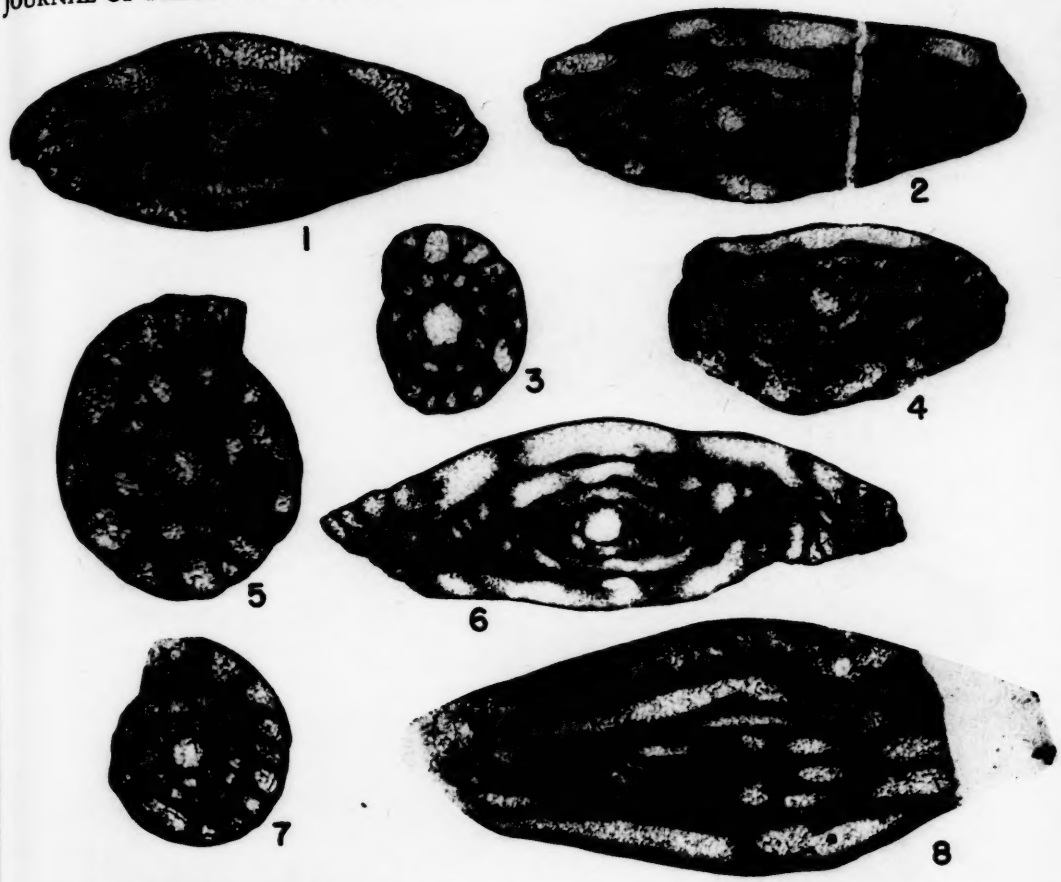
Genus FUSULINA Fischer de Waldheim
FUSULINA ACME Dunbar & Henbest
Pl. 134, figs. 1–4

Fusulina acme Dunbar & Henbest, 1942, Illinois Geol. Survey, Bull. 67, p. 122,123, pl. 15, figs. 1–18, pl. 16, fig. 14.

EXPLANATION OF PLATE 133

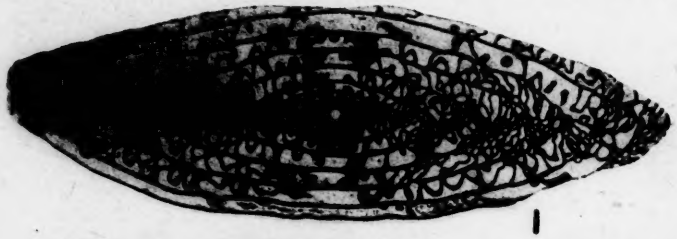
All specimens illustrated on this plate are from the Bishops Cap member of the Magdalena formation exposed in Vinton Canyon, Franklin Mountains, Texas.

FIGS. *1–10—Frumentella exempla* Stewart, n. gen., n. sp. *1*, Axial section of the holotype, ×70; *2,4,6*, axial sections of paratypes, ×70; *3,5,7*, sagittal sections of paratypes, ×70; *8*, tangential section of a large paratype, ×70; and *9,10*, detail enlargements illustrating the three layered spirotheca and erratically coiled juvenarium, ×300.


1
2
3
4
5
6
7
8

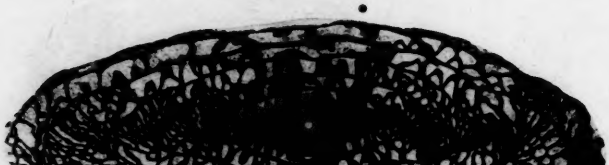
9

10

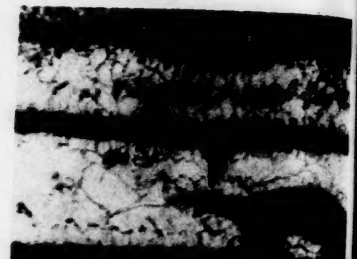


1

2



3



4

5

6

7

8

9

11

10

12

The shell of *Fusulina acme* is thickly fusiform in shape. Specimens of nine volutions, are 9.0 mm. long and 3.0 mm. wide, giving a form ratio of 1:3.0. Polar ends are slightly pointed to bluntly rounded. Volutions expand uniformly. The lateral slopes are gently convex with some irregularities. Proloculus is of moderate size, measuring 160 to 180 microns.

The thin spirotheca consists of four layers, a tectum, unusually thick diaphanotheca, and thin upper and lower tectoria. The tunnel angle begins near 17° and widens to 40° to 45° in the eighth volutions. The pseudochomota appear as secondary thickening around the septa adjacent to the tunnel and are very irregular in symmetry, becoming absent or indistinct in the last one or two whorls.

The septa are intensely and irregularly folded throughout the entire length of the shell. It is quite common for the tips of opposing folds to meet.

Occurrence.—This species is among the most common found in the Capps limestone and in the Village Bend limestone member of the East Mountain shale along the drainage of the Colorado River formation exposed in the drainage areas of the Brazos River. Collections have been made from these two limestones at the following localities: T-S-201, T-S-254, T-S-260, T-S-807, T-S-887, and T-S-908.

FUSULINA MEGISTA Thompson
Pl. 134, figs. 5–7

Fusulina megista THOMPSON, 1934, University of Iowa Studies, v. 16, no. 4, p. 320–323, pl. 23, figs. 4–6.

The test of *Fusulina megista* is robust and fusiform; with bluntly pointed poles, straight axis of coiling, and shallow external furrows. Mature specimens of 9 volutions measure 7.0 to 7.2 mm. in length and 2.3 to 2.7 mm. in width, giving a form ratio of 1:2.6. The juvenarium is tightly coiled around a spherical proloculus of 180 to 220 microns. The outer volutions expand uniformly.

The septa are relatively thick and composed of the same four layers as the spinotheca: the tectum, diaphanotheca, and upper and lower tectoria. The heavy tectoral deposits make the septa thick and cause them to bulge at the lower end. They are intensely and regularly folded and expand through the entire length of the chamber. The pseudochomata are composed of secondary deposits around the septa adjacent to the tunnel and are indistinct in the last volution. The tunnel is well defined and straight, with angles of 10° in the first volution to 29° in the eighth volution.

Occurrence.—This species occurs with *Fusulina acme*, but is far more abundant in the Village Bend limestone of the Brazos River drainage exposures than in the Capps limestone of the Colorado River drainage. It is abundant in localities: T-S-887 and T-S-907; and rare in localities: T-S-201, T-S-254, T-S-260, T-S-760, T-S-807 and T-S-908.

FUSULINA WHITAKERI Stewart, n. sp.
Pl. 134, figs. 8–12

Diagnosis.—The test of *Fusulina whitakeri* is elongate fusiform, with 8 to 9 volutions, slightly rounded polar extremities, and uniformly expanding volutions. The length of 7.3 to 8.5 mm. and width of 2.6 to 3.0 mm. gives a mature form ratio of 1:2.7 to 1:3.0. The small spherical proloculus

---

EXPLANATION OF PLATE 134

FIGS. *1–4—Fusulina acme* Dunbar & Henbest. *1,3*, Axial sections, ×10; *2*, sagittal section, ×10; *4*, detail of wall of *1* showing thick diaphanotheca and pseudochomata (P), ×70. *1*, from Village Bend limestone (T-S-887); *2*, Village Bend limestone (T-S-907); *3*, Village Bend limestone (T-S-908).

5–7—Fusulina megista Thompson. *5,6*, Axial sections, ×10; *7*, sagittal section, ×10; all specimens from the Village Bend limestone (T-S-887).

8–12—Fusulina whitakeri Stewart, n. sp. *8*, Axial section of holotype, ×10; *9,10*, axial sections of paratypes. ×10; *11,12*, sagittal sections of paratypes, ×10; all specimens are from the lower of two limestone lentils in the Brazos River sandstone formation (T-S-909B), Palo Pinto County, Texas.

TABLE 4.—MEASUREMENTS OF *Fusulina megista* THOMPSON, IN MILLIMETERS

Volution	Half Length				Radius Vector				Form Ratio			
	1	2	3	4	1	2	3	4	1	2	3	4
0	0.100	0.110	0.110	0.095	0.098	0.115	0.100	0.095	—	—	—	—
1	0.175	0.215	0.185	0.190	0.140	0.160	0.135	0.130	1.3	1.3	1.4	1.5
2	0.340	0.435	0.410	0.365	0.220	0.230	0.220	0.190	1.5	1.9	1.9	1.9
3	0.693	0.647	0.685	0.690	0.320	0.315	0.365	0.300	2.1	2.0	1.9	2.3
4	1.155	1.047	1.386	1.032	0.435	0.440	0.520	0.420	2.7	2.4	2.7	2.5
5	1.848	1.447	1.956	1.463	0.645	0.605	0.745	0.590	2.9	2.4	2.6	2.5
6	2.618	1.894	2.587	2.079	0.850	0.825	0.995	0.810	3.1	2.3	2.6	2.6
7	3.065	2.402	3.203	2.972	1.110	1.075	1.240	1.100	2.7	2.2	2.6	2.1
8	3.542	3.049	3.588	3.542	1.350	1.350	1.530	1.385	2.7	2.3	2.3	2.6
9	—	3.727			—	1.575	—	—	—	2.4	—	—

	Tunnel Angle (degrees)				Wall Thickness				Septal Count			
	1	2	3	4	1	2	3	4	1	2	3	4
1	13°	11°	—		0.020	—	0.025	—	—			
2	14°	12°	10°	12°	0.025	0.025	0.025	0.020	18	15	14	
3	15°	12°	15°	14°	0.025	0.020	0.025	0.025	19	19	23	
4	18°	15°	14°	15°	0.030	0.025	0.035	0.035	27	23	25	
5	27°	19°	15°	17°	0.030	0.030	9.030	0.030	28	28	27	
6	21°	18°	15°	18°	0.040	0.035	0.040	0.040	36	34	31	
7	27°	24°	29°	28°	0.035	0.040	0.040	0.045	40	38	37	
8	—	22°	—	—	0.045	0.040	0.045	0.040	43	43	39	
9	—	—	—	—	0.040	0.050	0.045	0.050	—	—		
10					—	0.050	—	—	—	—		

TABLE 5.—MEASUREMENTS OF *Fusulina whitakeri*, N. SP., IN MILLIMETERS

Volution	Half Length				Radius Vector				Form Ratio			
	1	2	3	4	1	2	3	4	1	2	3	4
0	0.065	0.062	0.050	0.062	0.060	0.063	0.050	0.065	—	—	—	—
1	0.140	0.133	0.187	0.102	0.085	0.105	0.125	0.090	1.6	1.3	1.5	1.1
2	0.215	0.218	0.390	0.367	0.135	0.140	0.210	0.185	1.6	1.6	1.9	2.0
3	0.630	0.413	0.717	0.540	0.210	0.225	0.350	0.285	3.0	1.8	2.0	1.9
4	1.016	0.663	1.248	1.053	0.300	0.320	0.565	0.455	3.4	2.0	2.2	2.3
5	1.170	0.858	2.121	1.560	0.435	0.455	0.820	0.690	2.7	1.9	2.6	2.3
6	1.586	1.622	2.886	2.340	0.610	0.670	1.040	0.950	2.6	2.4	2.8	2.5
7	2.464	2.886	3.744	3.120	0.870	0.925	1.275	1.255	2.8	3.0	2.9	2.5
8	2.972	3.900	—	3.978	1.100	1.205	—	1.575	2.7	3.2	—	2.5
9	4.158	—	—		1.330	—	—	—	3.1	—	—	—

	Tunnel Angle (degrees)				Wall Thickness				Septal Count			
	1	2	3	4	1	2	3	4	1	2	3	4
1	—	—	—	—	0.015	0.010	—					
2	11°	11°	10°	11°	0.010	0.010	0.015	0.010	10	11	11	
3	14°	14°	13°	13°	0.015	0.015	0.025	0.015	17	16	16	
4	15°	14°	18°	18°	0.025	0.025	0.025	0.025	20	20	20	
5	14°	17°	22°	17°	0.025	0.025	0.035	0.025	19	21	21	
6	15°	20°	21°	22°	0.030	0.030	0.040	0.025	27	29	25	
7	21°	25°	24°	24°	0.040	0.035	0.035	0.035	30	34		
8	20°	24°	—	25°	0.035	0.035	0.035	0.040	29	—		
9	27°	—	—	—	0.035	0.035	—	0.035				
10	—				0.035	—	—	—				

measures from 100 to 130 microns for the external diameter. Septa are strongly and irregularly fluted and average 10 in the first whorl to 30 in the seventh. The tunnel angle ranges from 13° in the first volution to 27° in the eighth volution. The tunnel is bordered by irregular pseudochomata formed mostly of secondary deposits around the septa. Some specimens, however, exhibit chomata that are symmetrical and well developed. Both of these deposits become indistinct in the last volution.

The spirotheca is of average thickness across the equatorial region and thins toward the poles. It is composed of a tectum, thin diaphanotheca, and upper and lower tectoria.

Remarks.—This species resembles *Fusulina expedita* Alexander from the Breezy Hill limestone of Oklahoma, but may be differentiated by an overall larger size, straight tunnel, more irregular septal fluting, and better developed chomata. This new species is named after D. G. Whitaker, who collected the material during stratigraphic studies for a Master of Arts degree at Texas Christian University.

Occurrence.—*Fusulina whitakeri*, n. sp. occurs abundantly in the lower of two thin limestone lentils of the Brazos River sandstone member of the Garner formation, Palo Pinto County, Texas, locality T-S-909B. This species is rare at localities T-S-909A and T-S-910.

Type.—Bureau of Economic Geology, University of Texas, Catalogue no. BEG 20485.

FUSULINA BRAZOSENSIS Stewart, n. sp.
Pl. 135, figs. 1–5

The shell of *Fusulina brazosensis* is elongate fusiform in shape, with pointed to slightly rounded polar ends and uniformly expanding volutions. The first 4 volutions are more tightly coiled than later ones. Specimens, of seven to eight volutions are 5.5 to 6.5 mm. long and 1.6 to 2.0 mm. wide, with an average form ratio of 1:3.4. Septa are thin and strongly fluted throughout the length of the shell and vary from near 14 in the first volution to near 32 in the sixth volution. The tunnel is narrow and straight and the angle increases from near 10° in the first volution to near 30° in the

TABLE 6.—MEASUREMENTS OF *Fusulina brazosensis*, N. SP., IN MILLIMETERS

Volution	Half Length				Radius Vector				Form Ratio			
	1	2	3	4	1	2	3	4	1	2	3	4
0	0.062	0.050	0.035	0.055	0.060	0.052	0.035	0.055	—	—	—	—
1	0.179	0.145	0.135	0.187	0.100	0.085	0.055	0.085	1.8	1.7	2.4	2.2
2	0.335	0.340	0.240	0.335	0.150	0.125	0.085	0.125	2.2	2.6	2.7	2.7
3	0.484	0.500	0.455	0.484	0.225	0.190	0.135	0.200	2.1	2.6	3.3	2.4
4	0.647	0.865	0.810	0.710	0.330	0.285	0.210	0.290	2.0	3.0	3.9	2.5
5	1.115	1.450	1.115	1.154	0.470	0.415	0.320	0.445	2.4	3.2	3.5	2.6
6	1.872	1.995	1.900	1.888	0.665	0.585	0.480	0.640	2.8	3.4	4.0	3.0
7	2.449	2.675	2.450	2.886	0.885	0.720	0.700	0.835	2.8	3.7	3.5	3.4
8	3.276	—	—	3.409	1.040	—	—	1.015	3.2	—	—	3.4

	Tunnel Angle (degrees)				Wall Thickness				Septal Count			
	1	2	3	4	1	2	3	4	1	2	3	4
1	—	—	—	—	0.015	—	—	—	—	—	—	
2	11°	13°	9°	11°	0.010	0.010	0.007	0.010	14	14		
3	13°	16°	15°	15°	0.010	0.015	0.010	0.015	19	17		
4	15°	18°	16°	10°	0.012	0.020	0.015	0.020	21	17		
5	24°	23°	18°	16°	0.015	0.010	0.025	0.015	22	22		
6	23°	29°	24°	24°	0.010	0.015	0.015	0.020	31	26		
7	36°	34°	30°	19°	0.020	0.025	0.015	0.025	32	30		
8	48°	—	40°	24°	0.040	0.030	0.035	0.025				
9	—				0.020	—	0.025	0.025				

sixth volution. The chomata are well developed and symmetrical throughout all volutions.

The proloculus is small and averages 80 microns in outside diameter. The four-layered spirotheca is thin and uniform in thickness, with the lateral slopes tending to be concave.

Remarks.—This species resembles *Fusulina whitakeri*, n. sp., but may be easily distinguished by its larger form ratio, smaller size, better developed true chomata, thinner wall, and more intense septal fluting.

Occurrence.—*Fusulina brazosensis*, n. sp. occurs throughout the Brazos River sandstone member of the Garner formation of Palo Pinto and Eastland Counties, Texas. The type specimens were collected from a thin fossiliferous limestone lentil between two sandstones of the Brazos River formation, Eastland County, Texas, T-S-910. Other collections are from locality T-S-909.

Type.—Bureau of Economic Geology, University of Texas, Catalogue no. BEG 20486.

FUSULINA VALIDA Stewart, n. sp.
Pl. 135, figs. 6–11

The shell of *Fusulina valida* is slightly inflated fusiform, with bluntly rounded polar ends and straight axis of coiling. Its length varies from 6.7 to 7.5 mm., its width varies from 2.5 to 3.0 mm. and its form ratio averages 1:2.8. The uniformly expanding volutions number 7 to 8 in mature specimens.

The septa are intensely and irregularly fluted through the shell and give a ribbon-like appearance in the last whorl of the axial section. Here they do not seem to touch the wall of the preceding volution and seem suspended in the middle of the chamber. The septal loops are asymmetrical and develop one over the other as in some species of *Schwagerina*.

The proloculus is large, subspherical to spherical in shape and measures from 230 to 300 microns in outside diameter. The tunnel is irregular and narrow with angles from 11° in the first volution to near 30° in the fifth. The pseudochomata are well developed, asymmetrical to bulbous, and extend high

TABLE 7.—MEASUREMENTS OF *Fusulina valida*, N. SP., IN MILLIMETERS

Volution	Half Length				Radius Vector				Form Ratio			
	1	2	3	4	1	2	3	4	1	2	3	4
0	0.117	0.148	0.156	0.132	0.115	0.142	0.155	0.135	—	—	—	—
1	0.273	0.250	0.265	0.242	0.180	0.165	0.200	0.160	1.5	1.5	1.3	1.5
2	0.679	0.476	0.421	0.608	0.295	0.250	0.295	0.235	2.2	1.9	1.4	2.5
3	0.881	0.757	0.780	0.741	0.445	0.390	0.405	0.345	2.0	2.0	1.9	2.1
4	1.318	1.115	1.108	1.303	0.660	0.615	0.575	0.505	2.0	1.8	1.9	2.5
5	1.934	1.747	1.958	2.020	0.925	0.670	0.830	0.715	2.1	2.6	2.4	2.8
6	2.785	2.418	2.536	2.870	1.205	0.860	1.085	0.950	2.3	2.8	2.3	3.0
7	3.276	3.058	3.048	3.658	1.350	1.110	1.250	1.175	2.4	2.8	2.4	3.1
8	—	3.510			—	1.300	—	—	—	2.7	—	—

	Tunnel Angle (degrees)				Wall Thickness				Septal Count			
	1	2	3	4	1	2	3	4	1	2	3	4
1	10°	12°	14°	9°	0.030	0.020	0.030	0.025	—	—		
2	11°	11°	11°	12°	0.030	0.025	0.030	0.020	18	18		
3	11°	16°	12°	18°	0.045	0.030	0.035	0.030	19	18		
4	14°	17°	16°	20°	0.050	0.040	0.035	0.035	20	19		
5	20°	22°	18°	28°	0.050	0.035	0.040	0.035	23	23		
6	26°	23°	24°	29°	0.050	0.040	0.045	0.035	28	28		
7	—	21°	—	—	0.045	0.040	0.050	0.035	31	32		
8					0.045	0.040	0.050	0.040	38	43		

above the chamber floor. In some cases, these deposits extend the entire height of the volution or chamber.

The spirotheca is composed of a tectum, thin diaphanotheca and thick upper and lower tectoria. It is of uniform thickness throughout the entire length of the test.

Remarks.—This species is characterized by the bulb-shaped pseudochomata, irregular septal fluting, and large proloculus. It may be differentiated from other forms of the upper Strawn of Texas by the thin diaphanotheca and the combination of features mentioned above. The specific name is derived from the Latin word meaning strong and powerful.

Occurrence.—*Fusulina valida*, n. sp., is abundant in the Village Bend limestone member of the East Mountain shale formation of locality T-S-887. It is common in the same limestone at locality T-S-908, associated with *F. acme*, *F. megista* and *F. gordonensis*, n. sp. Several specimens have been collected from locality T-S-760 in Eastland County, Texas.

Type.—Bureau of Economic Geology, University of Texas Catalogue no. BEG 20487.

FUSULINA LEEI Skinner
Pl. 135, figs. 12–17

Fusulina leei Skinner, 1931, Jour. Paleontology, v. 5, p. 257–258, pl. 30, figs. 4 and 6.

The shell of *Fusulina leei* is elongate fusiform, with bluntly rounded polar ends. Mature individuals of 7 volutions vary in length from 6.0 to 7.2 mm., and in width from 2.0 to 2.4 mm., giving a form ratio near 1:3.0. The septa are moderately folded and symmetrical in the axial section, and number 16 in the first whorl to 33 in the sixth. The proloculus is spherical in shape and is 180 to 220 microns across the external diameter.

The tunnel is straight, with angles of 11° in the first volution to 28° in the sixth volution. The chomata are strongly developed and asymmetrical in shape throughout all volutions. The spirotheca consists of four layers: the tectum, thin diaphanotheca, and an equally thin upper and lower tectoria. The wall is of uniform thickness throughout each volution.

Occurrence.—*Fusulina leei* was collected from the Berino member of the Magdalena formation in Vinton Canyon of the Franklin Mountains. It is included with the upper

TABLE 8.—MEASUREMENTS OF *Fusulina leei* SKINNER, IN MILLIMETERS

Volution	Half Length				Radius Vector				Form Ratio			
	1	2	3	4	1	2	3	4	1	2	3	4
0	0.093	0.101	0.094	0.109	0.090	0.100	0.092	0.110	—	—	—	—
1	0.265	0.211	0.211	0.217	0.150	0.170	0.130	0.185	1.8	1.2	1.6	1.2
2	0.523	0.367	0.374	0.530	0.240	0.250	0.220	0.280	2.2	1.5	1.7	1.9
3	0.764	0.647	0.725	0.936	0.355	0.360	0.340	0.445	2.1	1.8	2.1	2.1
4	0.992	1.014	1.045	1.263	0.500	0.520	0.515	0.605	2.0	2.0	2.0	2.1
5	1.903	1.638	1.810	1.872	0.695	0.700	0.725	0.845	2.7	2.3	2.5	2.2
6	2.652	2.262	2.652	2.863	0.900	0.900	0.950	1.090	3.0	2.5	2.8	2.6
7	3.251	3.354	3.458	—	1.220	1.140	1.215	—	2.7	2.9	2.8	—

	Tunnel Angle (degrees)				Wall Thickness				Septal Count			
	1	2	3	4	1	2	3	4	1	2	3	4
1	9°	11°	11°	11°	—	0.015	0.010	0.015				
2	14°	10°	13°	11°	0.010	0.010	0.015	0.010	16	16		
3	17°	14°	11°	11°	0.010	0.015	0.015	0.010	20	21		
4	13°	14°	15°	14°	0.015	0.015	0.015	0.018	27	19		
5	17°	21°	17°	18°	0.015	0.017	0.025	0.020	26	23		
6	19°	25°	18°	23°	0.018	0.020	0.020	0.020	30	26		
7	25°	28°	24°	27°	0.020	0.020	0.030	0.025	—	33		
8	—	—	—	—	0.020	0.020	0.035		—	39		

TABLE 9.—MEASUREMENTS OF *Fusulina vintonensis*, N. SP., IN MILLIMETERS

Volution	Half Length				Radius Vector				Form Ratio			
	1	2	3	4	1	2	3	4	1	2	3	4
0	0.046	0.070	0.046	0.054	0.045	0.068	0.045	0.051	—	—	—	—
1	0.141	0.188	0.078	0.093	0.080	0.100	0.055	0.080	1.8	1.9	1.4	1.7
2	0.343	0.507	0.204	0.351	0.150	0.184	0.105	0.125	2.3	2.8	2.0	2.7
3	0.694	0.974	0.522	0.615	0.260	0.324	0.180	0.205	2.7	3.0	2.9	2.9
4	0.940	1.718	0.923	0.901	0.445	0.535	0.314	0.349	2.1	3.2	2.9	2.6
5	1.634	2.324	1.544	1.482	0.685	0.785	0.400	0.555	2.4	3.0	3.9	2.6
6	2.554	3.240	2.458	2.102	0.950	1.030	0.675	0.810	2.7	3.1	3.6	2.6
7	3.190	—	3.500	3.103	1.125	—	0.945	1.050	2.8	—	3.7	3.0
8	—	—	4.250	3.656	—	—	1.136	1.310	—	—	3.6	2.8

	Tunnel Angle (degrees)				Wall Thickness				Septal Count			
	1	2	3	4	1	2	3	4	1	2	3	4
1					0.010	0.010	.008	0.010				
2	14°	13°	11°	11°	0.015	0.015	.009	0.010	11	9	11	
3	16°	20°	17°	17°	0.020	0.025	0.015	0.015	16	14	15	
4	23°	24°	24°	24°	0.020	0.020	0.015	0.015	16	16	18	
5	31°	32°	26°	24°	0.025	0.025	0.020	0.020	19	21	20	
6	29°	35°	35°	32°	0.025	0.025	0.030	0.025	20	25	23	
7	—	—	37°	36°	0.030	0.030	0.030	0.030	13		26	
8	—	—	28°	37°	0.030	—	0.035	0.030				
9							0.030	0.030				

Strawn forms because it occurs above *Wedekindellina* at this locality, T-S-803.

FUSULINA VINTONENSIS Stewart, n. sp.
Pl. 136, figs. 1–6

The shell of *Fusulina vintonensis*, n. sp., is of small size with elongate fusiform shape and pointed to slightly rounded poles. The length varies from 6.5 to 8.0 mm. and the width varies from 2.2 to 2.4 mm. The large form ratio varies from 1:3.0 to 1:3.7. The 7 to 8 volutions expand uniformly and tend to be concave on the lateral slopes. The proloculus is small, measuring 90 to 140 microns for the external diameter. The septa are intensely and irregularly fluted, with no symmetry throughout the test. The average septal counts for the first through the sixth whorls are 11,14,16,20,23 and 19, respectively. The average number of septa diminish in the last two whorls because some sagittal sections exhibit no septa for an arc of 45° to near 180°. This condition is illustrated by plate 136, figure 4.

The pseudochomata are hook-shaped toward the tunnel and are composed of secondary deposits around the septa. True chomata are present in some of the immature volutions. The tunnel has a slightly irregular path, with angles averaging 12°, 17°, 24°, 30°, 33°, 36°, and 37° from the first to the seventh volutions, respectively. The spirotheca is thicker across the tunnel, thins toward the poles, and is composed of a tectum, thick diaphanotheca, and thin upper and lower tectoria.

Remarks.—The smaller size, larger form ratio, irregular septal fluting and chomata in immature stages distinguish this species from *Fusulina whitakeri*, n. sp.

Occurrence.—*Fusulina vintonensis*, n. sp. is named after Vinton Canyon of the Franklin Mountains, El Paso County, Texas. Here it occurs in the Bishops Cap limestone member of the Magdalena formation with *Frumentella exempla*, n. sp. and *Plectofusulina franklinensis*, n. gen., n. sp., locality T-S-802.

Types—Bureau of Economic Geology, University of Texas Catalogue no. BEG 20488.

FUSULINA MYSTICENSIS Thompson
Pl. 136, figs. 7–9

Fusulina mysticensis THOMPSON, 1934, University of Iowa Studies, v. 14, no. 4, p. 319,320, pl. 23, figs. 1–3.

TABLE 10.—MEASUREMENTS OF *Fusulina mysticensis* THOMPSON, IN MILLIMETERS

Volution	Half Length				Radius Vector				Form Ratio			
	1	2	3	4	1	2	3	4	1	2	3	4
0	0.092	0.117	0.120	0.110	0.094	0.117	0.120	0.110	—	—	—	—
1	0.215	0.195	0.225	0.225	0.125	0.160	0.175	0.175	1.7	1.2	1.3	1.3
2	0.323	0.343	0.375	0.450	0.190	0.240	0.265	0.250	1.7	1.4	1.4	1.8
3	0.460	0.608	0.719	0.801	0.269	0.345	0.395	0.350	1.7	1.7	1.8	2.3
4	0.677	0.670	1.139	1.206	0.349	0.470	0.555	0.480	1.9	1.4	2.1	2.5
5	1.540	1.448	1.643	1.808	0.549	0.655	0.740	0.645	2.8	2.2	2.2	2.8
6	1.843	2.126	2.460	2.388	0.682	0.875	0.960	0.890	2.7	2.4	2.6	2.7
7	2.772	3.141	3.370	3.380	0.900	1.100	1.124	1.045	3.1	2.9	3.0	3.2
8	4.150	3.910	4.075	4.158	1.150	1.365	1.500	1.265	3.6	3.4	2.7	3.3
9	5.113	4.475	5.160	4.406	1.442	1.650	1.760	1.515	3.5	2.7	2.9	2.9

	Tunnel Angle (degrees)				Wall Thickness				Septal Count			
	1	2	3	4	1	2	3	4	1	2	3	4
1				11°	0.010	0.020	0.020	0.025				
2	12°	11°	9°	12°	0.010	0.015	0.010	0.015	14	18	14	18
3	12°	11°	14°	12°	0.015	0.015	0.015	0.015	18	23	20	23
4	20°	15°	15°	14°	0.010	0.015	0.020	0.015	22	23	23	25
5	25°	16°	17°	17°	0.025	0.020	0.025	0.020	26	31	26	27
6	24°	23°	17°	20°	0.025	0.025	0.025	0.025	31	35	34	32
7	25°	25°	21°	23°	0.030	0.025	0.030	0.030	36	37	36	36
8	30°	28°	34°	28°	0.025	0.030	0.030	0.035	40	44	45	41
9	27°	31°	—	37°	0.030	0.035	0.035	0.035	—	44	—	—
10	27°	—	—	—	0.035	0.035	0.030	0.030				

The shell of *Fisulina mysticensis* Thompson is large, elongated, and fusiform to subcylindrical, with rounded to slightly flaring poles. Mature specimens of 9 volutions vary from 9.0 to 10.0 mm. in length and 2.8 to 3.0 mm. in width. The form ratio averages 1:3.5 in the last two volutions. The proloculus is spherical and measures 180 to 240 microns across the external diameter.

The septa are thin, strongly fluted, and symmetrical to asymmetrical. The septal count averages 16, 20, 23, 26, 31, 36 to 44 in the first to the seventh volution, respectively. The thin spirotheca is composed of a tectum, thick diaphanotheca, and thin upper and lower tectoria. Tunnel is straight and is bordered by asymmetrical pseudochomata of secondary deposits around septa in most cases. However, a few dense layered deposits of true chomata were observed on the floor of the chamber and are not associated with septa.

Occurrence.—This species has been found at only one exposure of the upper Strawn of Texas, the upper Magdalena limestone in Powwow Canyon, Hueco Mountains, El Paso County, Texas, locality T-S-433G.

FUSULINA BELLATULA Stewart, n. sp.
Pl. 136, figs. 10–14

The test of *Fusulina bellatula* is elongate fusiform to sub-cylindrical in shape with acute to slightly rounded poles. Mature individuals of 9 to 10 volutions attain lengths of 6.5 to 8.0 mm. and widths of 1.8 to 2.2 mm., giving form ratios of 1:4.0 to 1:4.5. The tightly coiled volutions expand uniformly across the central part of the shell, but tend to flare in the polar regions. This later condition produces greater distances between the walls at the poles than over the tunnel area.

The proloculus is small, spherical in shape, and measures 80 to 130 microns across the external diameter. The tunnel is straight and its angle ranges from 9° in the first volution to near 30° in the seventh volution. The chomata are asymmetrical, high, and massive. In some individuals, the secondary deposits in the vicinity of the

TABLE 11.—MEASUREMENTS OF *Fusulina bellatula*, N. SP., IN MILLIMETERS

Volution	Half Length				Radius Vector				Form Ratio			
	1	2	3	4	1	2	3	4	1	2	3	4
0	0.055	0.040	0.064	0.054	0.054	0.040	0.063	0.050	—	—	—	—
1	0.086	0.124	0.096	0.086	0.080	0.060	0.090	0.070	1.1	2.1	1.1	1.2
2	0.203	0.288	0.234	0.166	0.115	0.105	0.140	0.110	1.8	2.7	1.7	1.5
3	0.288	0.506	0.402	0.296	0.170	0.160	0.205	0.170	1.7	3.2	1.9	1.7
4	0.560	0.881	0.708	0.510	0.240	0.225	0.295	0.239	2.3	3.8	2.4	2.1
5	0.968	1.182	1.161	0.941	0.325	0.340	0.424	0.395	2.9	3.5	2.8	2.4
6	1.323	1.822	1.722	1.462	0.445	0.465	0.585	0.452	2.9	3.9	2.9	3.2
7	2.101	2.650	2.260	2.065	0.580	0.600	0.750	0.640	3.6	4.4	3.0	3.2
8	2.960	3.450	3.090	2.400	0.745	0.760	0.970	0.845	4.0	4.5	3.2	2.9
9	3.800	—	—	3.047	0.945	—	—	1.022	4.0	—	—	3.0
10	4.210	—	—	—	1.045	—	—	—	4.0	—	—	—

	Tunnel Angle (degrees)				Wall Thickness				Septal Count			
	1	2	3	4	1	2	3	4	1	2	3	4
1					0.005	0.005	0.008	0.005				
2	9°	10°	9°	9°	0.008	0.005	0.005	0.005	13	14	13	12
3	12°	15°	14°	12°	0.010	0.008	0.010	0.008	16	20	17	16
4	13°	16°	16°	15°	0.010	0.010	0.010	0.010	19	24	21	20
5	18°	17°	19°	12°	0.015	0.012	0.015	0.015	28	30	26	24
6	22°	19°	20°	18°	0.015	0.018	0.020	0.015	30	32	29	28
7	26°	32°	25°	21°	0.020	0.020	0.020	0.020	33	41	33	27
8	36°	29°	28°	26°	0.020	0.025	0.030	0.020	41	40	40	33
9	44°	—	—	28°	0.025	0.030	0.030	0.025	40	44	40	39
10	—	—			0.030	—	—	0.030			41	
11	—	—			0.030	—						

chomata make it very difficult to distinguish the chromata from septal loops that have been filled.

The septa are regularly fluted throughout the test and form symmetrical loops in axial sections. They increase in number from about 13 in the first whorl to over 40 in the eighth. The thin, four-layered wall is composed of a tectum, thin diaphanotheca, and thicker upper and lower tectoria.

Remarks.—This species is given the Latin name *bellatula*, meaning neat and pretty, because of the geometric appearance of the septal fluting and distinct features of the chomata. These same features also may be used to distinguish *Fusulina bellatula*, n. sp. from *Fusulina piasaensis* Dunbar & Henbest, 1942. The smaller test, minute proloculus, and secondary deposits in the vicinity of the chomata also aid in the differentiation of this species from *F. piasaensis*.

Occurrence.—The type specimens of *Fusulina bellatula* were collected from the Village Bend limestone at locality T-S-907, where

EXPLANATION OF PLATE 135

FIGS. *1–5*—*Fusulina brazosensis* Stewart, n. sp. *1*, Axial section of the holotype, ×10; *2,3*, axial section of paratypes, ×10; and *4,5*, sagittal sections of paratypes, 10. Locality T-S-910, Eastland County, Texas.

6–11—*Fusulina valida* Stewart, n. sp. *6,9*, Axial sections, ×10; *7*, detail of wall and chomata of a paratype, ×70; *8*, axial section of the holotype, ×10; and *10,11*, sagittal sections of paratypes, ×10. *6*, from Village Bend limestone (T-S-908); *7,8,10,11*, from Village Bend limestone (T-S-887); *9*, from Capps limestone (T-S-760).

12–17—*Fusulina leei* Skinner. *12,15*, Sagittal sections, ×10; *13,14,16*, axial sections, ×10; and *17*, detail of wall and chomata of *13*, ×70. All specimens from Berino member of Magdalena formation, Vinton Canyon, Franklin Mountains, Texas. Locality T-S-803.

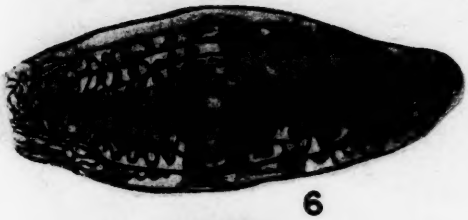
1

2

3

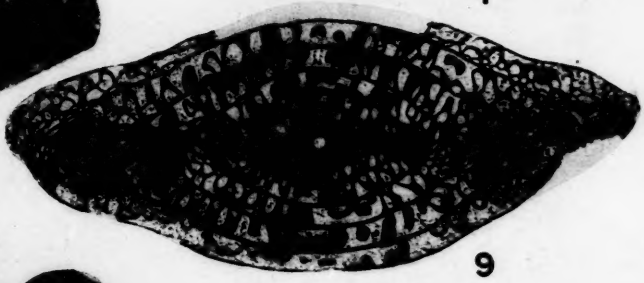
4

5


6

7

8


9

10

11

12

13

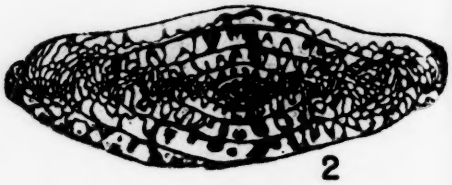
14

15

16

17

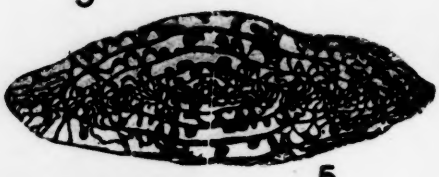
1



2

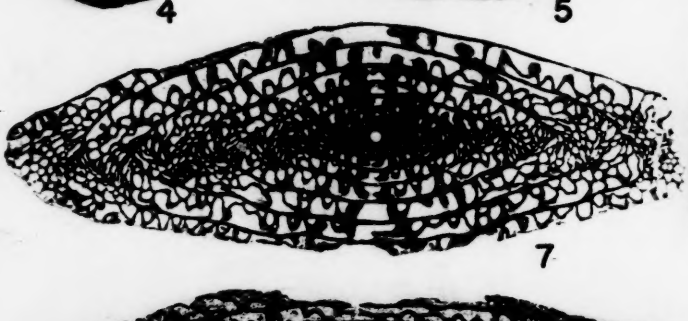
3

4



5

6



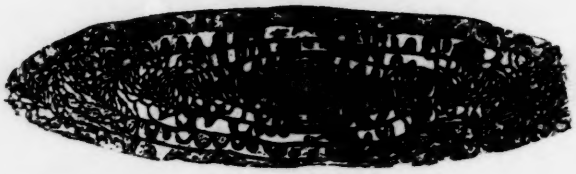
7

8

9

10

11



12

13

14

TABLE 12.—MEASUREMENTS OF *Fusulina gordonensis*, N. SP., IN MILLIMETERS

Volution	Half Length				Radius Vector				Form Ratio			
	1	2	3	4	1	2	3	4	1	2	3	4
0	0.062	0.046	0.054	0.064	0.060	0.045	0.050	0.064	—	—	—	—
1	0.203	0.102	0.107	0.141	0.105	0.095	0.085	0.100	1.9	1.1	1.3	1.4
2	0.304	0.273	0.288	0.257	0.150	0.145	0.125	0.150	2.0	1.8	2.2	1.7
3	0.561	0.452	0.467	0.540	0.214	0.210	0.190	0.250	2.7	2.1	2.5	2.2
4	0.840	0.740	0.700	0.866	0.314	0.310	0.275	0.369	2.7	2.4	2.5	2.3
5	1.194	1.490	1.192	1.204	0.450	0.455	0.400	0.545	2.7	3.2	3.0	2.2
6	1.563	1.720	1.622	1.722	0.650	0.650	0.545	0.745	2.4	2.7	2.9	2.3
7	2.156	2.262	2.201	2.400	0.855	0.865	0.750	0.975	2.5	2.6	2.9	2.5
8	2.656	2.856	2.820	3.015	1.150	1.095	0.965	1.300	2.3	2.6	2.9	2.3
9	3.034	3.132	—	3.432	1.335	1.330	—	1.542	2.3	2.4	—	2.3

	Tunnel Angle (degrees)				Wall Thickness				Septal Count			
	1	2	3	4	1	2	3	4	1	2	3	4
1	—	—	—	—	0.010	0.010	0.008	0.010				
2	10°	12°	14°	9°	0.010	0.010	0.010	0.010	11	10		
3	12°	14°	13°	13°	0.010	0.015	0.010	0.015	17	12		
4	15°	14°	16°	12°	0.015	0.015	0.015	0.015	23	16		
5	13°	17°	17°	22°	0.015	0.010	0.015	0.015	30	21		
6	20°	15°	20°	23°	0.015	0.015	0.015	0.020	34	26		
7	15°	16°	22°	22°	0.020	0.025	0.020	0.015	39	37		
8	20°	23°	24°	27°	0.025	0.025	0.025	0.025	37	33		
9	18°	19°	—	34°	0.030	0.025	0.030	0.030		32		
10					0.025	0.025	—	0.030				

they occur in great abundance with *Fusulina acme* and *F. megista*. This new species is also common in the Capps limestone of the upper Strawn exposed along the Colorado River at localities T-S-254, T-S-260, and T-S-807.

Type.—Bureau of Economic Geology, University of Texas Catalogue no. BEG 20489.

FUSULINA GORDONENSIS Stewart, n. sp.
Pl. 137, figs. 1–4

The shell of *Fusulina gordonensis*, is inflated fusiform, with slightly rounded poles. Mature individuals of 9 volutions range in length from 5.5 to 6.5 mm. and in width from 2.5 to 3.0 mm., giving form ratios of 1:2.0 to 1:2.5. The proloculus is minute, measuring 90 to 130 microns across the external diameter.

The septa are intensely and irregularly fluted and are the most complex of any species of *Fusulina* yet observed from Texas. The intensity of fluting is as great in the central portions of the test as in the axial extremities. The septal count averages 10, 15, 18, 25, 31, 38 and 37 for the first through the seventh whorls, respectively.

EXPLANATION OF PLATE 136

FIGS. *1–6*—*Fusulina vintonensis* Stewart, n. sp. *1*, axial section of holotype, ×10; *2,3,5*, axial sections of paratypes, ×10; *4*, sagittal section of paratype, ×10; and *6*, detail of *4*, ×70. Bishops Cap limestone, Magdalena formation, Vinton Canyon, Franklin Mountains, Texas. Locality T-S-802.

7–9—*Fusulina mysticensis* Thompson. *7,8*, Axial sections, ×10; and *9*, sagittal section, ×10. All specimens from upper Magdalena limestone, Powwow Canyon, Hueco Mountains, Texas. Locality T-S-433G.

10–14—*Fusulina bellatula* Stewart, n. sp. *10*, Axial section of the holotype, ×10; *11,12*, axial sections of paratypes, ×10; and *13,14*, sagittal sections of paratypes, ×10. Village Bend limestone, Palo Pinto County, Texas. Locality T-S-907.

The tunnel is indistinct and cannot be accurately defined in any of the growth stages of the species. Therefore, the angles given in the table of measurements are, in many cases, inferred. The condition of the tunnel is in part due to the intensive septal fluting and in part to the adjacent indistinct secondary deposits. These secondary deposits are excellent examples of pseudochomata since they are made of fill around the septa. They exhibit no layered structure and in most cases are not deposited on the chamber floor or preceding wall,

The spirotheca is composed of a tectum, thick diaphanotheca, and thick upper and lower tectoria. The uneven deposits of tectoria cause the wall to vary in thickness throughout any given volution. Some individuals exhibit deposits of axial filling in the nepionic stages.

Remarks.—The character of the septal fluting and the form ratio of this species distinguishes it from other species of this genus.

Occurrence.—*Fusulina gordonensis*, n. sp. was collected from the Village Bend limestone at localities not far removed from the town of Gordon, Texas, and is here named for that town. The types were collected from the above limestone at locality T-S-908. It occurs commonly with *F. bellatula*, n. sp., *F. acme*, and *F. megista* at locality T-S-907.

Types.—Bureau of Economic Geology, University of Texas, Catalogue no. BEG 20490.

FUSULINA CAPPENSIS Stewart, n. sp.
Pl. 137, figs. 5–9

Fusulina cappsensis, n. sp., has an elongate and sub-cylindrical shell, with bluntly rounded poles in the majority of individuals. Mature shells of eight to nine volutions attain a length of 6.0 to 7.0 mm. and a width of 2.0 to 2.3 mm., giving a form ratio of 1:3.5 to near 1:4.0. The volutions are tightly coiled in the nepionic stages and then expand uniformly into wider whorls.

The proloculus is minute, averaging around 100 microns across the external diameter. The tunnel is straight and wide, with angles near 10° in the first volution to

TABLE 13.—MEASUREMENTS OF *Fusulina cappsensis*, N. SP., IN MILLIMETERS

Volution	Half Length				Radius Vector				Form Ratio			
	1	2	3	4	1	2	3	4	1	2	3	4
0	0.054	0.047	0.060	0.062	0.055	0.045	0.060	0.061	—	—	—	—
1	0.085	0.072	0.142	0.109	0.070	0.065	0.100	0.095	1.2	1.1	1.4	1.1
2	0.148	0.124	0.217	0.210	0.110	0.110	0.140	0.140	1.3	1.1	1.5	1.5
3	0.350	0.273	0.311	0.429	0.161	0.152	0.194	0.205	2.2	2.0	1.6	2.1
4	0.715	0.615	0.600	0.948	0.244	0.245	0.291	0.320	2.9	2.5	2.1	3.0
5	1.045	0.976	1.378	1.340	0.355	0.345	0.415	0.455	3.0	2.9	3.0	2.9
6	1.561	1.464	2.020	2.075	0.600	0.485	0.575	0.650	2.6	3.0	3.5	2.5
7	2.550	2.344	2.601	2.702	0.700	0.640	0.750	0.855	3.6	3.7	3.5	3.1
8	3.102	3.350	3.122	3.588	0.891	0.850	0.931	1.082	3.5	3.9	3.4	3.3
9	3.425	3.682			1.168	0.972			2.9	3.8		

	Tunnel Angle (degrees)				Wall Thickness				Septal Count			
	1	2	3	4	1	2	3	4	1	2	3	4
1					0.008	0.008	0.009	0.008				
2	9°	11°	12°	14°	0.008	0.007	0.010	0.008	10	13		
3	17°	21°	15°	20°	0.010	0.008	0.010	0.009	18	17		
4	19°	21°	16°	20°	0.015	0.010	0.010	0.010	21	21		
5	26°	23°	17°	25°	0.015	0.015	0.015	0.015	23	24		
6	26°	31°	24°	34°	0.015	0.020	0.015	0.020	24	25		
7	41°	31°	20°	32°	0.020	0.025	0.025	0.025	26	29		
8	—	43°	24°	—	0.030	0.025	0.030	0.030	30	30		
9	—	—	—	—	0.035	0.030	0.030	—				
10					0.035	0.030						

near 45° in the seventh. The chomata are irregular and indistinct in the immature stages of the species, give rise to pseudochomata in the mature stages, and tend to disappear altogether in the last stages.

The septa are weakly fluted across the central area of the test, but are intensely fluted in the axial extremities. The average number of septa increases from 11 in the first whorl to 30 in the seventh. The spirotheca is very thin and is composed of four layers, with the diaphanotheca thin in comparison to the upper and lower tectoria.

Remarks.—This species has the least number of septal loops and the weakest septal fluting of any of the other forms described here. The closest relationship of this species is with *Fusulina lonsdalensis* Dunbar & Henbest, 1942, but may be distinguished by a smaller proloculus and form ratio, more tightly coiled nepionic stage and more irregularly shaped and weakly developed chomata and pseudochomata.

Occurrence.—*Fusulina cappsensis*, n. sp., was collected from the Capps limestone formation at locality T-S-807 and was not found in any of the other exposures of the Strawn.

Types.—Bureau of Economic Geology University of Texas, Catalogue no. BEG 20491.

FUSULINA cf. F. MEGISTA Thompson
Pl. 137, fig. 11

This form is here referred to as *Fusulina megista* since it exhibits the same form ratio, size, type of septal fluting and several other characteristics. Only a few specimens were found, and it is not clear if there are consistent variations from the above species. However, there are slight differences noted. The proloculus is generally smaller, the first three to four volutions are more tightly coiled and the pseudochomata are more massive.

Occurrence.—This species occurs with *Fusulina acme*, *F. megista*, and *F. valida*, n. sp. in the Village Bend limestone at locality T-S-908.

FUSULINA sp. A
Pl. 137, fig. 10

The single illustrated axial section is from the Village Bend limestone and occurs with *Fusulina gordonensis*, n. sp., *F. acme*, *F. megista* and *F. valida*, n. sp. It differs in certain respects from each one of these species. It is elongate-cylindrical in shape, has a large proloculus, very indistinct pseudochomata, slight septal fluting in the central portion of the shell and a thin four-layered wall containing a thick diaphanotheca. Even though each of these characteristics may be present in the other species described, no such combination is found in any one species.

This specimen is illustrated because it exhibits the least development of chomata and pseudochomata ever observed by the writer in the genus *Fusulina*. If the wall were not constructed of four layers, this form could be compared in most other characteristics with the genus *Schwagerina*, which appears also to have pseudochomata present in some species.

Occurrence.—This single specimen was collected from the Village Bend limestone at locality T-S-887.

REFERENCES

ALEXANDER, R. C., 1954, Desmoinesian Fusulinids of northeastern Oklahoma: Oklahoma Geol. Survey, Circ. 31, p. 1–67, 4 pls.

CHENEY, M. G. & EARGLE, D. H., 1951, Geological Map of Brown County, Texas: Texas Bureau Economic Geol., Univ. of Tex.

DUNBAR, C. O., & HENBEST, L. G., 1942, Pennsylvanian Fusulinidae of Illinois: Illinois Geol. Survey, Bull. 67, p. 1–167, 23 pls.

GANELINA, R. A., 1956, Foraminifera of the Visean (Carbon.) of the Moscow Basin: Microfauna U.S.S.R., Sbornik VIII, Leningrad.

KING, P. B., & KNIGHT, J. B., 1945, Description and Correlation of Upper Paleozoic Rocks of Hueco Mountains: U. S. Geol. Survey Prelim. Map. 36, sheet 2.

LEE, J. S., & CHEN, S., 1930, Huanglung Limestone and its Fauna: Nat. Res. Inst. Geol., Mem., v. 9, p. 85–144, 14 pls.

NELSON, L. A., 1940, Paleozoic stratigraphy of Franklin Mountains, West Texas: Am. Assoc. Petroleum Geologists, v. 24, p. 157–172.

PLUMMER, F. B., & HORNBERGER, J., 1955, Geology of Palo Pinto County, Texas: Texas Univ., Bull. 3534, 240 p.

PUTRJA, F. S., 1956, Stratigraphy and Foraminifera of the Middle Carboniferous Deposits of the eastern Donets basin: Microfauna U.S.S.R., Sbornik VIII, Leningrad.

RAUSER-CHERNOUSOVA, D., KIREVA, LEONTOVICH, ET AL., 1951, Middle Carboniferous Fusu-

linidae from the Russian Platform and Adjacent areas: Akad. Nauk., 380 p., 58 pls.
SKINNER, J. W., 1931, Primitive Fusulinids of the Mid-Continent region: Jour. Paleontology, v. 5, p. 253–259, 1 pl.
THOMPSON, M. L., 1934, The fusulinids of the Des Moines series of Iowa: Iowa Univ. Studies, v. 16, p. 277–332, 4 pls.
——, 1937, Fusulinids of the Subfamily Schubertellinae: Jour. Paleontology, v. 11, p. 118–125, 1 pl.
——, 1951, New Genera of Fusulinid Foraminifera: Cushman Found. Foram. Res., v. 2, p. 115–119, 2 pls.
——, & Thomas, H. D., 1953, Systematic Paleontology of the Fusulinids from the Casper Formation: Wyoming Geol. Survey Bull. 46, p. 1–56, 8 pls.
WHITAKER, D. G., 1956, Stratigraphic Study of Some Upper Strawn Beds of Palo Pinto County, Texas: Unpublished master's thesis, Texas Christian University, Fort Worth, Texas.

EXPLANATION OF PLATE 137

FIGS. *1–4—Fusulina gordonensis* Stewart, n. sp. *1*, axial section of the holotype, ×10; *2*, sagittal section of a paratype, ×10; *3*, detail of the wall and pseudochomata (P) of the holotype, ×70; and *4*, axial section, ×10; *1–3*, from Village Bend limestone, Palo Pinto County, Texas. Locality T-S-908; *4*, from Village Bend limestone of locality T-S-907.

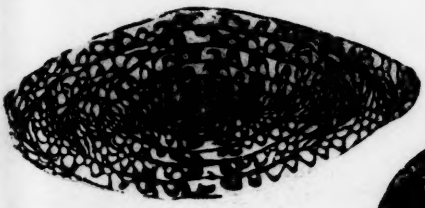
5–9—Fusulina cappsensis Stewart, n. sp. *5*, axial section of the holotype, ×10; *6,7*, axial sections, ×10; and *8,9*, sagittal sections of paratypes, ×10. *5,7,8*, and *9* from Capps limestone, Brown County, Texas (T-S-807); *6*, from Capps limestone of locality T-S-808.

10—Fusulina sp. A. Axial section from Village Bend limestone of locality T-S-887, ×10.

11—Fusulina cf. *F. megista* Thompson. Axial section from Village Bend limestone of locality T-S-908, ×10.

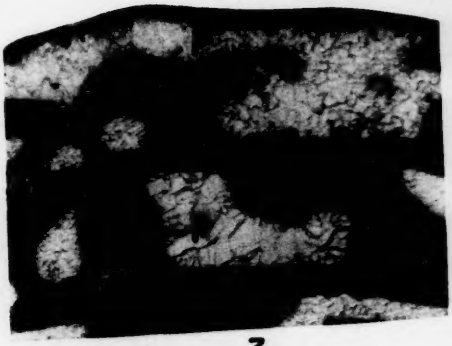
12,13—Paramillerella dogbendensis Stewart, n. sp. *12*, Axial section of holotype, ×70; *13*, sagittal section of paratype, ×70. Dog Bend limestone member, Salesville formation, Palo Pinto County, Texas. Locality T-S-908.

14,15—Fusiella texana Stewart, n. sp. *14*, axial section of holotype, ×70; and *15*, detail of *14*, ×260 approximately. Dog Bend limestone, Salesville formation, Palo Pinto County, Texas. Locality T-S-908.

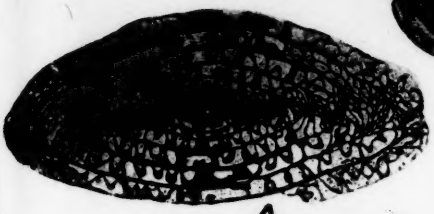


1

2

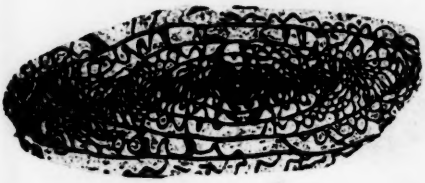


3



4

5



6

7

8

9

10

11

15

12

13

14

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

JOURNAL OF PALEONTOLOGY, V. 32, NO. 6, P. 1071–1075, PL. 138, 2 TEXT-FIGS., NOVEMBER 1958

CEPHALOPODS FROM THE BURGNER FORMATION IN MISSOURI

A. G. UNKLESBAY AND ERNEST J. PALMER
University of Missouri, Columbia, and Webb City, Missouri

ABSTRACT—The cephalopod fauna from the Burgner formation in southwestern Missouri contains goniatites referable to *Pseudoparalegoceras williamsi* Miller & Downs. The presence of this species tends to confirm an Atokan age assignment for the Burgner. Nautiloids are also present but are not diagnostic. One new species, *Temnocheilus searighti* is described.

INTRODUCTION

THE presence of relatively early Pennsylvanian rocks in Missouri was reported by Searight & Palmer in 1957, and to these rocks they applied the name Burgner formation.

Palmer has made rather extensive collections of fossils from these beds and they are currently being studied at the University of Missouri. The cephalopods are described in the present report and other groups will be reported in the future.

The cephalopod fauna consists mostly of nautiloids associated with one goniatite species. The nautiloids are not useful in age determination. Representatives of the following species have been recognized.

Mooreoceras normale Miller, Dunbar & Condra
Mooreceras sp.
Liroceras liratum (Girty)
Temnocheilus searighti n. sp.

The goniatites seem to be more diagnostic. Five well-preserved specimens appear to be conspecific and the larger ones seem to be essentially identical with those described by Miller & Downs as *Pseudoparalegoceras williamsi* (1948) from the "Winslow formation" of Arkansas. Miller and Downs interpreted the "Winslow" as being Atokan in age and wrote that *Pseudoparalegoceras williamsi* is "strikingly similar to and is almost certainly conspecific with numerous specimens in the collections available to us from typical Atoka sandstone north of Clarita, in south-central Oklahoma." Therefore, the occurrence of this species in the Burgner formation further supports the Atokan age determined for it by Thompson (1953) and later by Searight & Palmer (1957).

LOCALITIES

The localities from which the Burgner fossils have been collected are among several localities in the general vicinity of Webb City and are described as follows:

Locality 47. Mine Dump, SE¼ sec. 20, T. 28 N., R. 32 W., 1½ miles south of Carterville, Missouri. Shaft penetrated a considerable depth of black clay, clay shale, coal seams, and soft crumbling to hard limestone. The crumbling limestone and boulders of harder limestone were in places

EXPLANATION OF PLATE 138

FIGS. *1–3*—*Liroceras liratum* (Girty). Apertural, lateral, and ventral views, ×2, of specimen from locality 47. Univ. Mo. 13996.

4–7—*Temnocheilus searighti* Unklesbay & Palmer, n. sp. Lateral and ventral views of holotype, ×1, and cross sections at breaks indicated, ×2. Locality 47. Univ. Mo. 13997.

8–11—*Pseudoparalegoceras williamsi* Miller & Downs. *8*, lateral view of small specimen, ×2, Univ. Mo. 14001; *9*, lateral view of small specimen, ×6, Univ. Mo. 14000; *10*, lateral view of very small immature specimen, ×6, Univ. Mo. 13999; *11*, lateral view of large specimen, ×1, Univ. Mo. 13998. Locality 47.

12,13—*Mooreoceras* sp. Cross-section at large end of specimen ×3; and lateral view of same specimen, ×1. Locality 47. Univ. Mo. 13995.

14,15—*Mooreoceras normale* Miller, Dunbar & Condra. Lateral views of two specimens, both ×1. Locality 47. Univ. Mo. 13993, 13994.

abundantly fossiliferous with a very large number of well-preserved fossils.

Locality 48. Wilson's Coal Bank, NW¼ sec. 12, T. 28 N., R. 32 W., 1 mile west of Webb City, Missouri. Here, about 1890, seams of coal were encountered at depth of 20 or 30 feet below the surface in shafts sunk in search of lead. A small quantity was mined from shafts, but without much success. In 1892 a company was organized to operate it as a strip pit and the surface deposits of clay and gravel above shaly limestone, with some layers of harder stratified limestone up to 2 feet in thickness, were removed from an area of about 2 acres. Thick coal seams were uncovered and extensively mined. The coal varied greatly in quality as well as thickness and contained a great deal of shale, iron pyrite, and other impurities. The mine was soon worked out. Several pieces of silicified wood were found in the clay near the surface, and in the shaly and hard limestone a large number of marine fossils, some of them finely preserved, was found. Later and more extensive zinc mining operations have covered most of the old dumps, but traces of the limestone are still to be seen and a few fossils have recently been collected.

SYSTEMATIC PALEONTOLOGY

Genus MOOREOCERAS Miller, Dunbar & Condra, 1933

MOOREOCERAS NORMALE Miller, Dunbar & Condra

Pl. 138, figs. 14,15

(?) 1892. *Orthoceras colletti* MILLER, Indiana Dept. Geol. and Nat. Resources Ann. Rept. 18, Advance sheets, p. 67–68, pl. 10, fig. 1.

(?) 1894. *Orthoceras colletti* MILLER, Indiana Dept. Geol. and Nat. Resources Ann. Rept. 18, p. 321–322, pl. 10, fig. 1.

1931. *Orthoceras colletti* MORSE, Kentucky Geol. Survey, ser. 6, v. 36, p. 300,325–326, pl. 54, figs. 1,2.

1933. *Mooreoceras normale* MILLER, DUNBAR & CONDRA, Nebraska Geol. Survey Bull. 9, ser. 2, p. 87–89, pl. 2, figs. 5–7.

1934. *Mooreoceras normale* MILLER & OWEN, Univ. Iowa Studies Nat. Hist., v. 16, p. 203–205, pl. 11, figs. 1–8.

(?) 1938. *Mooreoceras normale?* MILLER & MOORE, Jour. Paleontology, v. 12, p. 343–344.

1939. *Mooreoceras normale* FLOWER, Palaeontographica Americana, v. 2, no. 10, p. 146–152.

1949. *Mooreoceras normale* SHIMER & SHROCK, Index Fossils of North America, p. 553, pl. 226, figs. 14,15.

1946. *Mooreoceras normale* STURGEON, Jour. Paleontology, v. 20, p. 14, pl. 3, figs. 10–12.

This species is represented in the Burgner collection by about 30 specimens. Only three of this group are at all well preserved, the others are fragmentary. In all specimens the shell is long, slender, straight, and gradually expanded orad. The angle between the lateral zones is about 7 degrees. The largest specimens are 31 mm. in diameter and represent portions of the living chamber. The best preserved specimen (Pl. 138, fig. 14) is about 89 mm. long and expands from 14 mm. in diameter at the adapical end to 25 mm. at the adoral end. It retains the shell throughout but appears to be all phragmacone. A smaller specimen (Pl. 138, fig. 15) is 20.4 mm. long and is 5.8 mm. wide at the adoral end. It is also completely septate. All other specimens are septate fragments of medium and small size.

The shell is moderately thick but it is devoid of growth lines or ornamentation.

The septa are simple and saucer-shaped, being moderately convex apicad. They are directly transverse to the length of the shell and the sutures are essentially straight.

The siphuncle is very slightly off center, presumably ventrad. Where it passes through the septa it is very small but the septal necks are sharply recurved and the siphuncle is greatly expanded within the camerae. Where one specimen is 6.5 mm. wide the siphuncle is only about 0.4 mm. where it goes through the septum.

Remarks.—Although these specimens are fragmentary their general physiognomy, cross section, nature of siphuncle, apical angle, and septal spacing all closely resemble those of the types of the species.

Occurrence.—Burgner formation, at localities 47 and 48.

Repository.—Univ. Mo. 13993,13994.

MOOREOCERAS sp.

Pl. 138, figs. 12,13

One small specimen in the collection does not seem to be conspecific with previously described species of this genus. The conch is straight, slender, and gradually expanded

orad. The cross section is circular being neither compressed or depressed. It is 13 mm. long, 2.8 mm in diameter at the adapical end, and 3.9 mm. in diameter at the adoral end. It is septate throughout. The septa are mildly concave and directly transverse so that the sutures are straight. The test is free of ornamentation and is moderately thick. The siphuncle is small, being only 0.5 mm. at the adoral septum. It is distinctly ventrad of the center.

Remarks.—This specimen is not referred to a previously described species because of its circular cross section. A new species is not being established because this specimen is not complete enough to serve as the basis for a new species.

Occurrence.—Burgner formation, locality 47.

Repository.—Univ. of Mo. 13995.

Genus LIROCERAS Teichert 1940

LIROCERAS LIRATUM (Girty)

Pl. 138, figs. 1–3

1911. *Coloceras liratum* GIRTY, New York Acad. Sci., Ann., v. 21, p. 144,145.
1915. *Coloceras liratum* GIRTY, U. S. Geol. Survey Bull. 544, p. 237,238, pl. 28, figs. 2–6a.
1922. *Coloceras liratum* PLUMMER & MOORE, Univ. Texas, Bull. 2132, p. 219.
1924. *Coloceras liratum* MORGAN, Okla. Bur. of Geol. Bull. 2, p. 232, pl. 51, fig. 4.
1933. *Coloceras liratum* MILLER, DUNBAR & CONDRA, Nebr. Geol. Survey, Bull. 9, 2nd ser., p. 132–134, pl. 6, figs. 1–8.
1940. *Liroceras liratum* TEICHERT, Jour. Paleontology, v. 14, p. 590.
1944. *Liroceras liratum* SHIMER & SHROCK, Index Fossils of N. America, p. 545, pl. 223, figs. 8–10.
1946. *Liroceras liratum* STURGEON, Jour. Paleontology, v. 20, p. 19–21, pl. 4, figs. 6–9.

One specimen of this widespread species is available for study. It is small, being about 16 mm. from venter to venter across the umbilicus. It is only a portion of a nautiliconic phragmacone. At the adoral end this specimen is 11.7 mm. wide and the dorsal-ventral height is 6.4 mm. The depth of the impressed zone is 2.2 mm. The ventral and lateral zones are broadly rounded, the umbilical wall is steep and the dorsal zone is deeply impressed so that the preceding whorl is largely enclosed. The depth of the impressed zone is much less on the earlier parts of the shell. The portion of the preceding whorl enclosed by the adoral end of this specimen is broadly elliptical and shows no impressed zone. The umbilicus is relatively small and deep. At the adoral end it is nearly 3 mm. deep.

Portions of the shell adhere to the specimen. Those on the larger portion do not show growth lines or ornamentation but on an inner whorl the shell is marked by strong longitudinal lirae which are crossed by fine closely spaced transverse lirae.

The septa are moderately concave and well spaced. There are 11 camerae represented in this specimen. The sutures are slightly sinuous forming broad shallow ventral lobes and equally broad shallow lateral saddles. The siphuncle is very small and is dorsad of the center. Where the shell is 11.7 mm. wide the siphuncle is only 0.7 mm. in diameter.

Remarks.—Although this specimen is smaller than most described representatives of this species, its general shape and shell ornamentation are clearly diagnostic.

Occurrence.—Burgner formation, locality 47.

This species is wide ranging and has been reported from the Wewoka, Boggy, Copan, and Wetumka formations of Oklahoma; the Jacksboro and Graham formations of Texas; the Weston shale of Kansas; and from the Hamden formation of Ohio.

Repository.—Univ. Mo. 13996.

TEMNOCHEILUS SEARIGHTI

Unklesbay & Palmer, n. sp.

Pl. 138, figs. 4–7

One specimen from the Burgner formation is available for study and it is the holotype. It is essentially complete and consists of a little more than one and a quarter volutions. It is septate for more than half its length. The maximum diameter of this specimen is 41 mm. At the adoral end the last volution is 20.5 mm. wide and 16 mm. high, and is broadly elliptical in cross-section being rounded across the ventral and lateral zones and only very slightly impressed on the dorsum. Near the end of the first quarter-volution the cross-section is nearly circular and is 5 mm. wide and 4 mm. high. There is a broadening with growth and in the second half of the first volution the width gains over the height. There is also developed a slight flattening of the venter

which in the last half volution develops into a faint broad shallow groove along the venter.

The test is thin, being only a little more than a millimeter in thickness at the adoral end. In the first half volution it is marked by fine longitudinal lirae of which there are six on the lateral zone. On the ventral zone the lirae are not well preserved but there appears to have been six there also. The lirae do not continue more than three-fourths of the first volution. Transverse markings are not present in this species as they are in other species of this genus.

Each ventro-lateral zone of the shell is marked by a single row of prominent nodes. They are essentially rounded cones and are distinct individuals. Their bases do not coalesce as do those of other species of *Temnocheilus*. There are 14 nodes on each side of this specimen. The early part of the shell does not bear nodes.

The septa are slightly convex apicad. They are more strongly curved in the dorso-ventral plane than in the lateral plane. The sutures are essentially transverse to the long axis of the conch and are nearly straight except for very shallow lateral lobes. The siphuncle is small and is very slightly ventrad of the center. Where the shell is 9.7 mm. wide the siphuncle is 0.8 mm. in diameter.

Remarks.—This species is distinct from other species of this genus in having both a shallow median ventral groove and distinct rounded individual nodes. *T. johnsoni* Miller, Dunbar & Condra has the median groove but its nodes are coalescent near the base and are elliptical in cross-section with the long axis parallel to the length of the shell. The nodes of *T. harneri* Miller & Owen are also more elliptical in cross-section. *T. quinqueliratus* Sturgeon has distinct nodes but does not have a ventral groove. *T. coxanum* Meek & Worthen is very similar to *T. searighti* but has no ventral groove.

Occurrence.—Burgner formation, locality 47.

Holotype.—Univ. of Missouri 13997.

PSEUDOPARALEGOCERAS WILLIAMSI
Miller & Downs
Pl. 138, figs. 8–11; text figs. 1,2

(?) 1937. *Phanerocerus compressum* [part] PLUMMER & SCOTT, Texas Univ. Bull. 3701, p. 15,16,30,33,191–193,194,220,281, pl. 9, figs. 4–10; pl. 11, fig. 13.

1948. *Pseudoparalegoceras williamsi* MILLER & DOWNS, Jour. Paleontology, p. 677–678, pl. 101, fig. 5; pl. 102, figs. 1–5; pl. 103, figs. 6–9.

Five specimens referable to this species all came from the same locality. They range greatly in size and maturity but seem to be related. The largest is 84 mm. in diameter and the smallest is only 5.7 mm.

The largest specimen is entirely septate and much of it retains at least the inner layer of the shell. It consists of at least four volutions. A trace of the umbilical wall of at least another quarter volution is preserved on the lateral zone of the last volution. Near the adoral end, the conch is about 39 mm. wide and the height between the umbilical shoulder and the venter is 32 mm. The shell is compressed laterally and rounded ventrally. The ventrolateral zones are rounded and the umbilical shoulder is angular. The umbilical walls are steep and nearly flat. The angle between the lateral zone and the wall is slightly over 90 degrees. The umbilicus is large and open, and is about four-tenths of the diameter.

No surface markings are present on this specimen. Although there is some shell adhering, it seems likely that it is only the inner layer because there is no trace of growth lines or surface ornamentation preserved.

The sutures (Text-figs 1,2) are not well preserved but they consist of a large bifid ventral lobe with hastate prongs. On either side of it is a narrowly rounded first lateral saddle, a large hastate first lateral lobe and a broad

TEXT-FIG. 1—Diagrammatic representation of a mature external suture of *Pseudoparalegoceras williamsi* from the Burgner formation in Missouri, ×1½. Based on adoral suture of the specimen shown in Fig. 11 on Plate 1. Diameter 76 mm.

TEXT-FIG. 2—Diagrammatic representation of immature external suture of *Pseudoparalegoceras williamsi* from the Burgner formation, ×6. Based on specimen shown in Fig. 8 on Plate 1. Diameter 12 mm.

asymmetrical second lateral saddle which extends over the umbilical shoulder into a lobe on the umbilical wall. The internal suture is not determinable on this specimen.

Three of the smaller specimens range in size from 8.3 to 13.7 mm. They all appear to be immature stages of the same species.

The smallest specimen consists of only slightly more than one volution. It is the only one of the five which bears shell ornamentation. This ornamentation is reticulate and consists of fine longitudinal lirae crossed by fine evenly-spaced growth lines. The transverse growth lines have moderate ventral sinuses.

Remarks.—Of the several species of *Pseudoparalegoceras* these specimens conform most closely to *P. williamsi* Miller & Downs. The only apparent difference is that the small specimens do not show transverse constrictions as do those they described. However, their specimens were internal molds and those at hand are testiferous and the constrictions may be concealed. They are also closely similar to *P. compressum* (Hyatt) but they expand less rapidly and have a smaller umbilicus than does that species.

Occurrence.—The specimens described are from the Burgner formation, locality 47.

The holotype of the species is from the "Winslow formation" at Winslow, Washington County, Arkansas.

Repository.—Univ. of Mo. 13998–14002, incl.

REFERENCES

GIRTY, GEO. H., 1915, Fauna of the Wewoka formation of Oklahoma: U. S. Geol. Survey, Bull. 544, 353 p., 35 pls.

MILLER, A. K., & DOWNS, R. H., 1948, A cephalopod fauna from the type section of the Pennsylvanian "Winslow Formation" of Arkansas: Jour. Paleontology, v. 22, p. 672–680, pls. 101–103.

——, DUNBAR, C. O., & CONDRA, G. E., 1933, The nautiloid cephalopods of the Pennsylvanian system in the Mid-Continent Region: Nebraska Geol. Survey Bull. 9, 2nd ser., 240 p., 24 pls.

SEARIGHT, WALTER V., & PALMER, ERNEST J., 1957, Burgner Formation, pre-Desmoinesian Pennsylvanian deposit in southwestern Missouri: Amer. Assoc. Petrol. Geologists Bull., v. 41, p. 2127–2132.

STURGEON, M. T., 1946, Allegheny fossil invertebrates from eastern Ohio—Nautiloidea: Jour. Paleontology, v. 20, p. 8–37, pls. 3–9.

THOMPSON, M. L., 1953, Primitive *Fusulinella* from southern Missouri: Jour. Paleontology, v. 27, p. 321–327, pls. 41,42.

JOURNAL OF PALEONTOLOGY, V. 32, NO. 6, P. 1076–1081, PLS. 139–140, 1 TEXT-FIG., NOVEMBER 1958

ANISOCERAS AND *ANCYLOCERAS* FROM THE TEXAS CRETACEOUS

DAVID L. CLARK
Southern Methodist University

ABSTRACT—*Anisoceras* and *Ancyloceras* have been confused for a number of years in the literature concerning lytoceratids in the Texas Cretaceous. Study of these genera shows that *Ancyloceras* ranges from the Upper Barremian to the Lower Aptian and can be distinguished by its trituberculate ribs from *Anisoceras* which is restricted to Upper Albian to Upper Turonian beds and has bituberculate ribs. The final straight shafts of these genera are similar in shape but the fossils are not closely related as *Ancyloceras* coils in one plane in its youthful stages, whereas *Anisoceras* shows early helical coiling.

Reexamination of the genera reported indicates that no valid *Ancyloceras* has been described from Texas. Three species of *Anisoceras* are known; *A. bendirei* (Adkins), *A.* cf. *A. armatum* (Sowerby), and *A. salei* Clark, n. sp.

INTRODUCTION

THE perplexing problem of Cretaceous ammonoid lineages has been amplified by the abundant but often not too critical literature concerned with descriptions of forms. The interpretation of many species described 30 or more years ago has changed. It now becomes necessary to reexamine many of these earlier descriptions in order to establish valid generic and specific identity. In doing this the stratigraphic range of genera often is altered. What has been the range of one genus may be reduced or expanded depending on the present assignment of members of the genus. Reexamination in light of our present knowledge should not only consolidate the voluminous and sometimes confusing literature, but also give us better ideas of lineages in Cretaceous ammonoids.

ACKNOWLEDGMENTS

The writer benefited from correspondence with C. W. Wright and from discussions with Tatsuro Matsumoto. John T. Lonsdale, Director of the Bureau of Economic Geology, Austin, Texas, and Keith Young, University of Texas, have made specimens available for study. This study was made possible by National Science Foundation grant G6364.

DISCUSSION

Ancyloceras (Pl. 139, fig. 1) was established by d'Orbigny in 1840 for a rather heterogeneous group of uncoiled ammonoids. In this early interpretation of *Ancyloceras*, nontuberculate, bituberculate, and trituberculate forms with a range of Jurassic to Neocomian were included in the genus (d'Orbigny, 1840). In our present understanding, only those trituberculate forms with a "plane open spiral followed by fairly long shaft and final hook" are assigned to *Ancyloceras* (Wright, 1957). Such forms have been reported from the Upper Barremian to the Lower Aptian in Europe (Astier, 1850), Australia (Whitehouse, 1926), South America (Royo y Gomez, 1945), and Japan (Wright, 1957).

In North America, *Ancyloceras* occurs in the Barremian of California (Anderson, 1938), and has been reported from the Upper Cretaceous of South Dakota (Meek, 1876), the Cretaceous of Oklahoma (Hill, 1889a), the Upper Albian of Texas (Adkins, 1920), the Upper Cretaceous of Texas (Shumard, 1860; Hill, 1889b), and the Upper Albian and higher beds of Mexico (Böse, 1923; Böse & Cavins, 1928).

The California species agree morphologically and stratigraphically with *Ancyloceras s. s.* (Pl. 139, fig. 1). The South Dakota specimen has only ventral tubercles and is not an *Ancyloceras*. The Oklahoma specimen is nontuberculate and Shumard's specimen from the Eagle Ford has only ventral tubercles (White, 1883, p. 39, pl. 18). Böse & Cavin's determinations of Upper Albian forms are not supported by any details and apparently were "based on earlier un-

critical determinations in the literature" (personal communication, C. W. Wright, 1957). Adkins' "*Ancycloceras*" *bendirei* (1920), is a straight shaft with a 180 degree hook but is from the Upper Albian. The specimen is bituberculate and does not belong with *Ancyloceras*. Only the California species are referable to *Ancyloceras s. s.* and are favorably comparable with *Ancyloceras* from the classic Barremian beds of France (d'Orbigny, 1840; Astier, 1850).

The genus *Anisoceras* was established by Pictet in 1854 (p. 705) for helical coiled irregular ammonoids from the Gault. The early helical spire gives rise to several straight shafts in the mature form. The present definition of *Anisoceras* (Wright, 1957) departs little from the original definition, i.e., uncoiled ammonoids with an early helical spire ending in one or more straight shafts with prominent lateral and ventral tubercles. *Anisoceras* occurs in beds of Upper Albian to Upper Turonian age and is widespread, having been reported from Europe (Pictet, 1854; Spath, 1939), Africa (Spath, 1925), Asia (Stoliczka, 1866), and North America (Adkins, 1920; Böse, 1923; 1928).

Adkins (1920; 1928) and Scott (1926) mention *Anisoceras* sp. aff. *A. armatum* (Sowerby) from the Pawpaw (Upper Albian) of north Texas and Adkins (1928) lists an *Anisoceras* sp. ? from the Duck Creek (Upper Albian) of this same area. Evidently these specimens were not placed in a museum and their present location has not been found. Recent collecting at the localities where the originals were found has failed to uncover additional material. Neither the *Anisoceras* sp. ? nor the *A.* sp. aff. *A. armatum* were figured and only *A.* sp. aff. *A. armatum* was described. This specimen is most surely an *Anisoceras* as the tuberculation and the suture (Adkins, 1920) are in accord with our present understanding of the genus. Spath (1939) places this specimen in his synonomy of *A. armatum* (Sowerby).

The slight resemblance that the final straight shaft of *Anisoceras* has with similar portions of *Ancyloceras* has resulted in some confusion of these genera. They can be distinguished by their stratigraphic occurrence and their tuberculation when only the straight shaft is found. *Anisoceras* is restricted to Upper Albian through Upper Turonian age rocks and is bituberculate while *Ancyloceras* is restricted to the Upper Barremian to Lower Aptian rocks and is trituberculate (Text-fig. 1).

Adkins' *Ancyloceras bendirei* (1920) from the Weno (Upper Albian) is bituberculate and is in reality the straight shaft of an *Anisoceras*. This specimen is apparently distinct from *Anisoceras* sp. aff. *A. armatum* from the Pawpaw and *A.* sp. ? from the Duck Creek, the only other two species of *Anisoceras* reported from Texas. Several other specimens of *Anisoceras*, two representing a new species, have been collected during the past 20 years. All are Upper Albian.

Spath (1942) reported that fragmentary *Anisoceras* specimens are abundant in the upper beds of the English Gault. Only seven specimens representing three species have been reported from the extensive Cretaceous outcrops of Texas. Of these, *A. armatum* (Sowerby) is world-wide in distribution but *A. bendirei* (Adkins) and *A. salei* Clark, n. sp., have been reported only from Texas. *Ancyloceras s. s.*, abundant in the Lower Cretaceous of other parts of the world has not been reported from the Texas Cretaceous.

SYSTEMATIC PALEONTOLOGY

Suborder LYTOCERATINA Hyatt, 1889
Superfamily TURRILITACEAE Meek, 1876
Family ANISOCERATIDAE Hyatt, 1900
Genus ANISOCERAS Pictet, 1854

ANISOCERAS BENDIREI (Adkins)

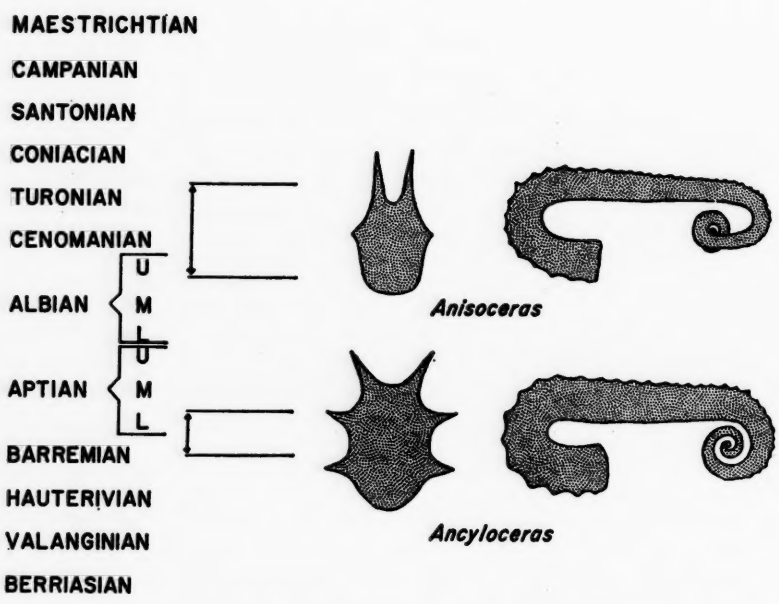
Pl. 190, fig. 1,2

Hamites sp. B WINTON & ADKINS, 1920, Univ. Texas Bull. 1931, p. 22.

Ancycloceras bendirei ADKINS, 1920, Univ. Texas Bull. 1856, p. 5,48,70,71, pl. 11, fig. 1; SCOTT, 1926, Univ. Grenoble These, Fac. des. Sci., p. 74,76,190.

Ancyloceras bendirei BÖSE, 1928, Univ. Texas Bull. 2748, p. 146; ADKINS, 1928, Univ. Texas Bull. 2838, p. 21,216.

Anisoceras bendirei (Adkins) was described as an *Ancyloceras* even though Adkins recognized that it had two instead of three tubercles on each side of the heavy ribs. The holotype was not adequately figured (1920) and is refigured here. Also, additional material has been collected which adds to our understanding of the species.



TEXT-FIG. *1*—Range, whorl section, and form of *Anisoceras* and *Ancyloceras*.

All known specimens of this species are well preserved and shell and suture are present. Adkins (1920) has given a rather complete diagnosis. The most important features are the rounded-hexagonal whorl shape, the wide venter, and the rather large spinose tubercles. The four rows of tubercles are ventral and lateral in position, a pair of each on a heavy, broad rib. These bituberculate ribs are separated by three to four fine intermediate ribs which are nontuberculate. The intermediate ribs disappear between the tuberculate ribs near the venter but are exposed over the dorsum. The bituberculate ribs are persistent and instead of terminating at the position of the lateral tubercles as in many species of *Anisoceras*, they extend down toward the dorsal margin a distance as great as that between the lateral and ventral tubercles. These broad ribs carry across the venter.

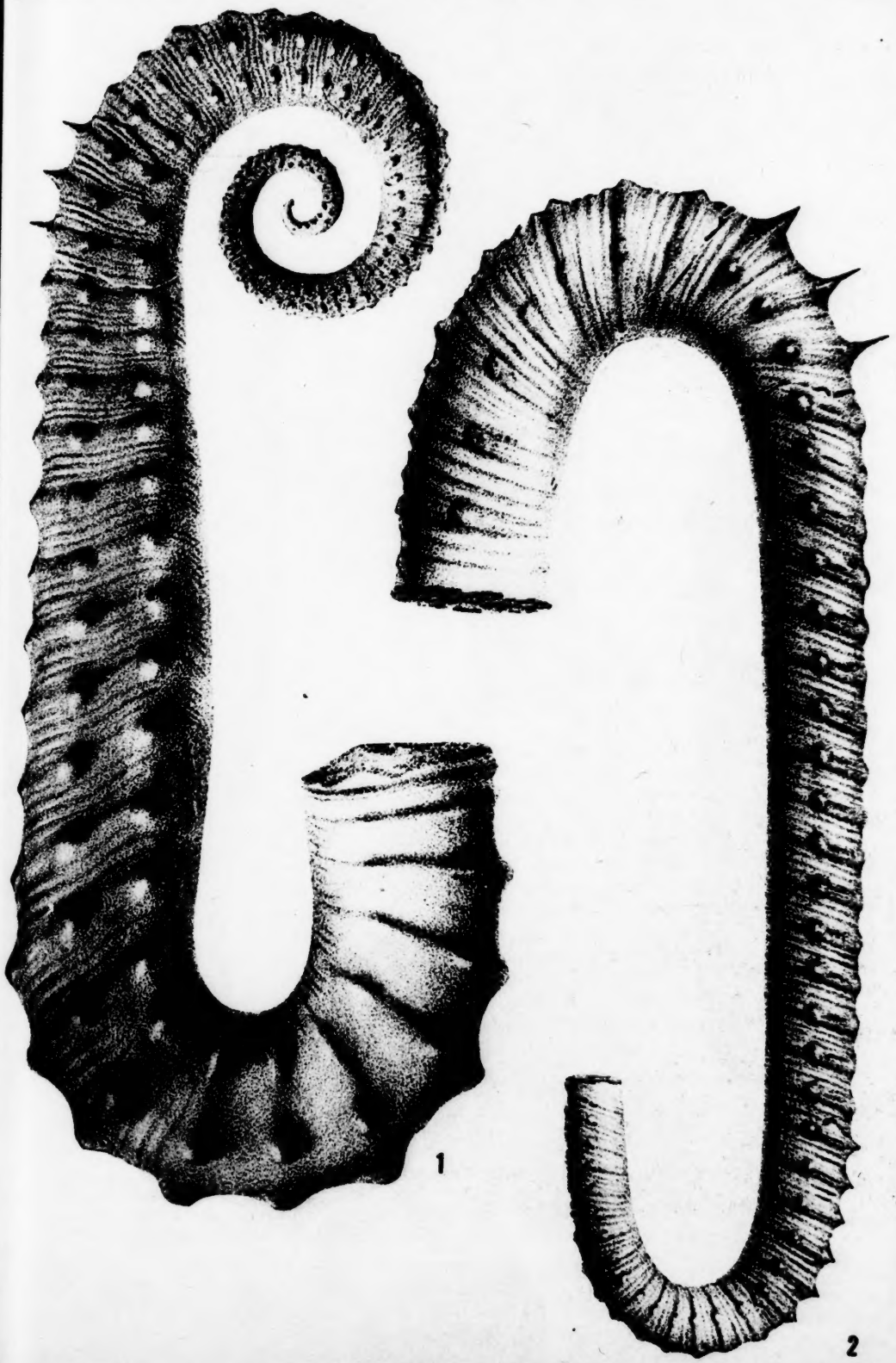
The suture (Adkins, 1920) is clearly of the *Anisoceras saussureanum* type and very similar to that suture illustrated by Spath (1939) and by Wright (1957).

Remarks.—This species is most similar to *Anisoceras saussureanum* (Pictet) and *A. perarmatum* Pictet & Campiche. It is considered as a separate species because of the number of intermediate ribs, the whorl shape, and especially by the extension of the broad tuberculate ribs almost to the dorsal margin. The whorl shape, tuberculate rib extensions, and midlateral location of the tubercles exclude it from *A. armatum* (Sowerby) and also from the Mexican species of Böse (1923), the Indian species of Stoliczka (1866), and the French species of Boule,

EXPLANATION OF PLATE 139

FIG. *1*—*Ancyloceras matheronianum* d'Orbigny. Specimen from the Barremian of France. After d'Orbigny, ×0.4.

2—*Anisoceras armatum* (Sowerby). Specimen based on restoration of various fragments. After d'Orbigny, ×0.7.


1
2

1
2
3

moine, & Thevenin (1906).

Occurrence.—The holotype was collected ut ten feet above the top of the Denton rl in the basal Weno Formation, near Ft. rth, Texas (Adkins loc. 618). Two other cimens assigned to this species are from Weno, south of Katy Lake, in Ft. rth, and were collected by Scott and Nel-

Repository.—University of Texas, Bureau Economic Geology, 20271 (holotype), and xas Christian University, M544, N262.

ANISOCERAS SALEI Clark, n. sp.
Pl. 140, fig. 3

isoceras sp. SALE, 1957, M.A. Thesis, Texas Christian Univ., p. ii,33,34,92, pls. 18,19.

The holotype, a large internal mold, was tained from the Duck Creek Formation ar Ft. Worth, Texas. The specimen is a ing chamber and has been slightly shed. It is about 500 mm. long, 100 mm. its greatest height, and 80 mm. at greatest width. Even though slightly shed, if it could be restored to its original ape it would be higher than wide. Con-ecific specimens confirm this. The venter narrow and the sides are flattened. The apical portion was broken from the ragmocone margin and only a trace of the ture remains. The adoral portion is sug-stive of the apertural margin. Heavy tu-rcle bearing ribs are separated by four to intermediate fine ribs on the main shaft. his shaft is connected by a 180 degree hook a smaller straight shaft, the adapical por-on. On the smaller shaft there are two in-rmediate ribs. The ribs are slightly oblique the hook to vertical on the shafts. Two ws of ventral and lateral tubercles are esent, a pair of each on every heavy rib. he ventral tubercles are large and on the olotype distorted. The lateral tubercles e the larger and are situated below the iddle of the whorl side. The tubercles on the final shaft are between 35 and 43 mm. apart and average less than 38 mm. The whorl shape is highly compressed. The fragmentary suture shows clearly the *Anisoceras* type, i.e., two large dissected lateral lobes, and three lateral saddles, the medial one being deeply bifed and the largest, the dorsal-lateral being the smallest.

Remarks.—The only other specimen referred to this species was loaned by the Texas Bureau of Economic Geology. Adkins recognized that the specimen represented a new species and had given it the manuscript name of *A. sheppardi.* The specimen was collected in 1937 by Mrs. M. T. Sheppard of Salado, Texas from a gravel pit south of Belton, Texas. The specimen is larger and not as crushed as the holotype but the details of the intermediate ribbing are not so well shown. It demonstrates the broad connecting hoops of the tuberculate ribs over the venter. Also, on the 180 degree hook there are present two to three ventral tubercles between the bituberculate ribs, a feature not well shown on the holotype.

Anisoceras salei is most similar to *A. armatum* (Sowerby) and *A. saussureanum* (Pictet). The compressed whorl section, flattened sides, narrow venter, and position of lateral tubercles below the middle of the whorl side shows its relationship to *A. armatum.* However, the irregular number of intermediate ribs on the final shaft, the broad connecting hoops of the tuberculate ribs over the venter, and the distance apart of the outer tubercles is suggestive of *A. saussureanum.* Spath (1939) considered the distance apart of the outer tubercles the most important point in separating *A. armatum* from *A. saussureanum.* In *A. saussureanum* the tubercles on the final shaft are usually about 45 mm. apart, or twice as far as in *A. armatum.* In *A. salei,* n. sp., with specimens as large as those of *A. saussureanum,* the outer tubercles average less than 38 mm.

EXPLANATION OF PLATE 140

IG. *1,2*—*Anisoceras bendirei* (Adkins). Lateral and ventral views of holotype from basal Weno Formation near Ft. Worth, Texas. Univ. Texas Bur. Econ. Geol. 20271, ×1.

3—*Anisoceras salei* Clark, n. sp. The holotype from the Duck Creek Formation in southwest Ft. Worth, Texas. S.M.U. 35003, ×½.

apart. This is greater than the distance apart in *A. armatum* but not as great as in equal size specimens of *A. saussureanum*. *A. salei* stands intermediate between *armatum* and *saussureanum* in position of outer tubercles as well as the other important taxonomic features.

The size of the specimen and number of intermediate nontuberculate ribs suggest a similarity to *Anisoceras exoticum* Spath. In *A. exoticum*, however, the inner tubercle is faint or absent whereas in *A. salei* the inner tubercles are always prominent. Also, the compressed whorl section of *A. salei* distinguishes it from the circular *A. exoticum*.

Anisoceras salei differs from *A. oldhamianum* Stoliczka and *A. raynaudi* (Boule, Lemoine & Thevenin) in the nature and placement of tubercles and whorl shape, and from *A. angulatum* Stoliczka in ribbing and tuberculation. It is not similar to any of the species described by Böse (1923) from Mexico.

Occurrence.—The holotype was collected by Clarence M. Sale in 1950. It came from about ten feet above the *Mortoniceras trinodosa* zone of the Duck Creek Formation which is 20 feet above the base of the Formation. This compares favorably to the occurrence of large *Anisoceras* in the *auritus* and *aequatorialis* subzones of the Upper Albian in England (Wright, personal communication, 1957). The holotype was found about 2000 feet west of the northwest corner of the old TCU Airport, about 4000 feet north of the L. C. Wright residence in southwest Ft. Worth, Texas. The Bell County specimen was found in a gravel pit about three miles south of Belton on the east side of U. S. Highway 81. The stratigraphic relationships at this locality suggest that the specimen was weathered from the lower part of the Duck Creek Formation.

Repository.—Museum of Paleontology, Southern Methodist University, 35003 (holotype). The Bell County specimen is in the Bureau of Economic Geology, 17398.

ANISOCERAS cf. A. ARMATUM (Sowerby)
Pl. 139, fig. 2

Hamites sp. aff. *H. armatus* ADKINS, 1920, Univ. Texas Bull. 1856, p. 51, p. 69–70: SCOTT, 1926, Univ. Grenoble These, Fac. des Sci., p. 80; BÖSE, 1928, Univ. Texas Bull. 2748, p. 146; ADKINS, 1928, Univ. Texas Bull. 2838, p. 24. *Anisoceras* sp. aff *A. armatum* ADKINS, 1928, Univ. Texas Bull. 2838, p. 211.

Attempts to locate this specimen were unsuccessful but according to Adkins' description (1920) this specimen is definitely an *Anisoceras*. The presence on every second or third rib of a pair of ventral and lateral tubercles indicates it is of the *armatum* type. The suture description (Adkins, 1920) is similar to those described for *armatum* also.

Occurrence.—Adkins locality 714, basal Pawpaw Formation, near Ft. Worth, Texas. Additional collecting at this locality has not produced other specimens.

REFERENCES

ADKINS, W. S., 1920, The Weno and Pawpaw Formations of the Texas Comanchean: Univ. Texas Bull. 1856, 172 p., 11 pls.

——, 1928, Handbook of Texas Cretaceous fossils: Univ. Texas Bull. 2838, 385 p., 37 pls.

ANDERSON, F. M., 1938, Lower Cretaceous deposits in California and Oregon: Geol. Soc. America, Spec. Paper 16, 339 p., 83 pls.

ASTIER, M. J., 1850, Catalogue descriptif des *Ancyloceras* appartenant a l'étage Néocomien d'escragnolles et des Basses-Alps: Annal. Sci. Physiques et Naturelles, d' Agric. et Indust. de Lyon, t. 111, 2nd ser., p. 435–456, pls. 15–23.

BÖSE, EMIL, 1923, Algunas faunas Cretacicas de Zacatecas, Durango y Guerrero: Inst. Geol. Mexico, Bol. 42, 219 p., 19 pls.

——, 1928, Cretaceous ammonites from Texas and northern Mexico: Univ. Texas Bull. 2748, p. 143–312, 18 pls.

——, & CAVINS, O. A., 1928, The Cretaceous and Tertiary of southern Texas and northern Mexico: Univ. Texas Bull. 2748, 142 p.

BOULE, MARCELLIN, LEMOINE, PAUL, & THEVENIN, ARMAND, 1906–07, Paléontologie de Madagascar, Pt. 111, Céphalopodes Crétacés des environs de Diego Suarez: Annal. Paléont., t. 1–2, p. 1–76, 15 pls.

HILL, R. T., 1889a, Paleontology of the Cretaceous formations of Texas: Univ. Texas, School of Geol., pt. 1, 4 p., 3 pls.

——, 1889b, A preliminary annotated check list of the Cretaceous invertebrate fossils of Texas: Geol. Surv. Texas, Bull. 4, 57 p.

MEEK, F. B., 1876, A report of the invertebrate Cretaceous and Tertiary fossils of the Upper Missouri country: U. S. Geol. Survey Rept. Territories, v. IX, 629 p., 45 pls.

ORBIGNY, ALCIDE d', 1840–42, Paléontologie francaise; Terrains crétacés, I, Céphalopodes: Paris, 662 p., 148 pls.

PICTET, F. J., 1854, Traité de paléontologie ou histoire naturelle des animaux fossiles zoologiques et geólogiques: Paris, 1853–57, v. 1, text, 727 p., v. 2, plates, 77 p., 110 pls.

ROYO Y GOMEZ, JOSE, 1945, Fossiles del Barremiense Colombiano: Serv. Geol. Nac., Comp. de los estud. geol. oficial. Col., t. VI, p. 455–494, pls. 70–75.

SALE, C. M., 1957, Geology along the Clear Fork of the Trinity River southwest of Fort Worth, Texas, including Benbrook Lake: unpublished M.A. thesis, Texas Christian University, 96 p., 50 pls.

SCOTT, GAYLE, 1926, Études stratigraphiques et paléontologiques sur les terrains crétacés du Texas: Univ. Grenoble Thèse, 218 p., 3 pls.

SHUMARD, B. F., 1860, Descriptions of new Cretaceous fossils from Texas: Trans. Acad. Sci. St. Louis, v. 1, no. 4, p. 590–610.

SPATH, L. F., 1925, On Upper Albian Ammonoidea from Portuguese East Africa, with an appendix on Upper Cretaceous ammonites from Maputoland: Ann. Trans. Mus., v. XI, pt. 3, p. 179–200, 10 pls.

——, 1939, A monograph of the Ammonoidea of the Gault, Part 13: Palaeont. Soc., 1938, p. 541–608, pls. LIX–LXIV.

——, 1942, *ibid.*, Part 15, 1942, p. 669–720.

STOLICZKA, F., 1866, Fossil Cephalopoda of the Cretaceous rocks of southern India: Mem. Geol. Surv. India, Palaeont. Indica, ser. 3, pt. 10–13, p. 155–216, pls. 76–94.

WHITE, C. A., 1883, Contributions to invertebrate paleontology, no. 2; Cretaceous fossils of the western states and territories: U. S. Geol. Survey Territories, 1878, pt. 1, p. 5–39, pls. 2–18.

WHITEHOUSE, F. W., 1926, The Cretaceous Ammonoidea of Eastern Australia: Mem. Queensland Mus., v. VIII, pt. 3, p. 195–242, pls. XXXIV–XLI.

WINTON, W. M., & ADKINS, W. S., 1920, The geology of Tarrant County: Univ. Texas Bull. 1931, 122 p., 6 pls.

WRIGHT, C. W., 1957, Mesozoic Ammonoidea [*in* Part L, Treatise on invertebrate paleontology; R. C. Moore, Ed.] Geol. Soc. America, L80–L490, figs. 124–558.

JOURNAL OF PALEONTOLOGY, V. 32, NO. 6, P. 1082–1093, PLS. 141–142, 1 TEXT-FIG., NOVEMBER 19

AN UPPER DEVONIAN CONODONT FAUNA FROM THE DARBY FORMATION OF THE WIND RIVER MOUNTAINS, WYOMING

GILBERT KLAPPER
Shell Oil Company, Baton Rouge, Louisiana

ABSTRACT—The upper part of the Darby formation at two localities in the Wind River Mountains, Fremont County, Wyoming, has yielded a fairly well preserved Upper Devonian conodont fauna. The Darby formation has not previously been the subject of a detailed paleontological study. Approximately 40 percent of the specimens are referable to the genera *Polygnathus* and *Spathognathodus*. The genera *Palmatolepis*, *Icriodus*, and *Apatognathus*, which are characteristic of the Upper Devonian, are also represented. Three species are new; *Icriodus darbyensis*, *Icriodus mehli*, and *Polygnathus wyomingensis*. This fauna is considered to be contemporaneous with part of the Saverton shale fauna of Missouri. In the past the Saverton fauna has been mistakenly referred to the Grassy Creek shale. The Darby fauna is tentatively correlated with zone V (*Clymenia*-Stufe) of the Famennian stage in Germany.

INTRODUCTION

BRANSON & Mehl (1938) and Branson & Branson (1941) noted the presence of conodonts in a black shale near the top of the Darby formation at Bull Lake Creek, Wind River Mountains, Wyoming. It was this occurrence which prompted the author to undertake a study of the conodonts of the Darby formation. The collections were assembled from two localities in Fremont County, Wyoming; at Bull Lake Creek and at Dinwoody Canyon. No fossils except conodonts were found.

PREVIOUS WORK

Blackwelder (1918) first named and described the Darby formation from the type section at Darby Creek on the west slope of the Teton Range in northwestern Wyoming. At this locality the Darby overlies the Leigh dolomite member of the Bighorn dolomite and underlies the Madison limestone. The Darby is described as a varied sequence of shales and dolomites at the type locality. Blackwelder considered the Darby to be Middle and Upper Devonian and equivalent to the upper part of the Jefferson limestone and the Three Forks shale of Montana.

Branson & Mehl (1938) mentioned the occurrence of the genus *Icriodus* from near the top of the Darby formation at Bull Lake Creek. In their distribution chart of *Icriodus*, they correlated the Darby formation with the Grassy Creek shale of Missouri. *Icriodus* is listed as Middle and Upper Devonian on Branson & Mehl's distribution chart for the genus. Later, Branson & Branson (1941) listed the following conodont genera presumably from the same black shale near the top of the Darby at Bull Lake Creek: *Polygnathus*, *Palmatolepis*, and *Icriodus*. Species from the Darby were not described or identified in either of these papers.

Andrichuk (1956) correlated, on the basis of lithology, the upper Darby with the Three Forks shale and the lower Darby with the Jefferson limestone. He described the Jefferson or lower Darby lithology as a relatively pure carbonate and the Three Forks or upper Darby lithology as a mixture of clastics (shales and some sandstone) and carbonates. In the Wind River Mountains, the lower Darby beds extend only a short distance south of Warm Springs and are not present as far south as Dinwoody Canyon or Bull Lake Creek, where the faunal collections under consideration were made.

COLLECTING LOCALITIES

The collections of conodonts studied were assembled from two localities in Fremont County, Wyoming; one 2 miles above Bull Lake, the other at the head of Dinwoody Canyon. At the former locality an incomplete section of the Darby formation is exposed on the south side of Bull Lake Creek in sec. 10, T. 2 N., R. 4 W., Bull Lake West Quadrangle (Text-fig. 1). The outcrop of the top of the Darby meets Bull Lake Creek 0.8 miles southwest of the gaging station at Bull Lake Falls located in sec. 2, T. 2 N., R. 4 W. This outcrop is not readily acces-

sible but is best reached by boat from Bull Lake Dam and then by foot 1.5 miles west from the lower falls which are located at the head of Bull Lake. Bull Lake Dam is 2 miles west of U. S. Highway 287, approximately 45 miles north of Lander.

The principal fauna was obtained from a black shale four feet below the top of the Darby formation. The following section was measured from the base of the Madison limestone to the base of the exposure of the Darby on the south side of Bull Lake Creek:

Base of Madison limestone forms a prominent ledge.

Darby formation.

Bed Number	Lithology	Feet
1	Dolomite, brown	3.2
2	Dolomite, gray, shaly	.6
3	Shale, black—contains most of the fauna	.3
4	Dolomite, brown, shaly	.4
5	Shale, black—contains some of the fauna	.3
6	Dolomite, green, shaly	3.2
7	Dolomite, brown, with maroon shale parting at top	1.4
8	Dolomite, brown, forms resistant ledge	1.2
9	Dolomite, bright red and yellow, weathers in angular blocks	1.7
10	Dolomite, green and maroon, shaly	2.4
11	Sandstone, white, forms resistant ledge	3.0
12	Dolomite, shaly	1.1
13	Sandstone, light red and white	1.4
14	Sandstone, white, forms resistant ledge	1.0
15	Sandstone, red	1.4
16	Dolomite, brown and green, vugs of calcite crystals	11.1
17	Dolomite, green, shaly	1.3
18	Dolomite, brown, vugs of calcite crystals, lower part weathers in angular fragments	8.6
19	Dolomite, brown	2.0
	Total	45.6

Below this the Darby is covered.

On the north side of Bull Lake Creek, 1 mile west of the gaging station at Bull Lake Falls, a complete section of the Darby formation was measured from the base of the Madison limestone to the top of the Bighorn dolomite. The Darby here is approximately 100 feet thick and is composed of thin-bedded dolomites and interbedded variegated shale. None of the shale units yielded conodonts. The dolomite was not sampled. The fossiliferous black shale four feet below the top of the formation on the south side of Bull Lake Creek was not found on the north side.

A black shale which yielded a few conodonts was found about eight feet below the top of the formation at the head of Dinwoody Canyon. This exposure is reached by foot a short distance east of Mud Lake. A fairly good road along the north side of Dinwoody Creek proceeds from U. S. Highway 287 approximately eight miles west to Mud Lake.

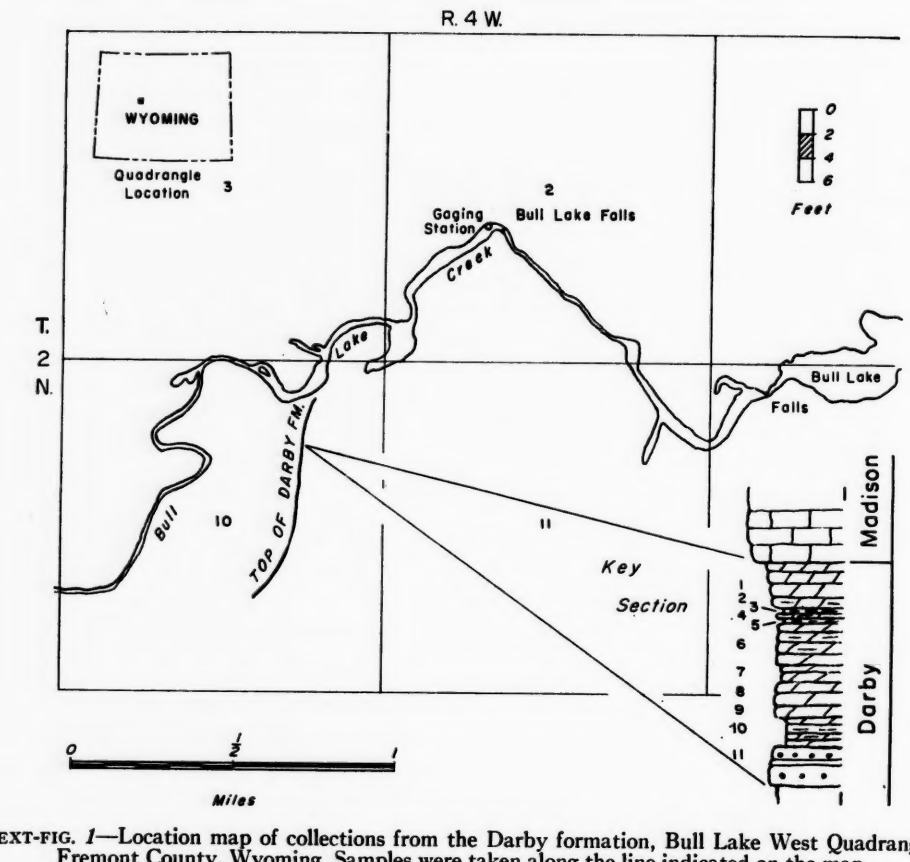
The conodonts were easily removed from the shale samples by the bromoform method of separating conodonts from the lighter material. About 250 specimens were obtained, half of which were well enough preserved to be specifically identified.

Holotypes of the new species and all figured specimens from the Darby formation have been deposited at the U. S. National Museum, Washington, D. C.

AGE OF THE DARBY CONODONTS

The presence of *Icriodus* which is restricted to the Devonian and of *Palmatolepis* which is restricted to the Upper Devonian is evidence of the Upper Devonian age of the Darby conodont fauna. The exact position of the Devonian-Mississippian boundary with regard to some formations in the Mississippi Valley area is still in dispute. However, the conodont work of Branson & Mehl has shown the existence of a significant faunal break between the Devonian and Mississippian. The Upper Devonian formations contain at least thirteen conodont genera (including *Icriodus*, *Palmatolepis*, and *Apatognathus*) which do not occur in the basal Mississippian. In the Lower Mississippian formations at least nine genera of conodonts appear for the first time, including such common genera as *Siphonodella*, *Solenodella*, and *Gnathodus*. None of these latter genera is represented in the Darby fauna.

The majority of specimens in the Darby fauna are conspecific with types listed from the Grassy Creek shale of Missouri. Branson & Mehl (1934) did not distinguish the bluish-gray clay shale, lying between the Grassy Creek shale and the overlying Louisiana limestone, from the Grassy Creek. At that time they considered this upper unit to be



TEXT-FIG. *1*—Location map of collections from the Darby formation, Bull Lake West Quadrangle, Fremont County, Wyoming. Samples were taken along the line indicated on the map.

TABLE 1—DARBY CONODONT SPECIES AND THEIR STRATIGRAPHIC DISTRIBUTION

Species	Formation from which originally described	Range in Germany‡
Apatognathus varians (2)*	Saverton†	V
Hindeodella cf. *H. acuta* (24)	Saverton†	—
Ozarkodina regularis (9)	Bushberg	Iγ–cuI
Palmatolepis gonioclymeniae (15)	V or VI, Effenberg	V or VI
Palmatolepis rugosa (11)	Saverton†	IIIβ–IV (V?)
Polygnathus inornata (2)	Hannibal	IIIα–cuIIIα
Polygnathus nodocostata (3)	Saverton†	—
Polygnathus triangularis (4)	Saverton†	?–cuIIγ
Polygnathus varinodosa (2)	Saverton†	—
Spathognathodus aculeatus (25)	Saverton†	—
Spathognathodus jugosus (12)	Saverton†	V (cu II—isolated occurrence)
New Species		
Icriodus darbyensis (6)	Darby	—
Icriodus mehli (1)	Darby	—
Polygnathus wyomingensis (8)	Darby	—

* Number of specimens.
† Grassy Creek of Branson and Mehl (1934).
‡ Zone numbers refer to Upper Devonian, unless preceded by cu which refers to Mississippian.

weathered material from the Grassy Creek shale proper. Actually this clay shale is the Saverton and contains the so-called Grassy Creek fauna. Mehl states (personal communication) that the specimens described and figured as Grassy Creek by Branson & Mehl (1934) are, for the most part, not from the Grassy Creek shale as he now conceives the boundaries of that unit. He defines the Grassy Creek shale as a dark brown to black fissile shale, which yields few conodonts. Mehl considers the Saverton fauna to be Upper Devonian.

Müller & Müller (1957) discuss the Grassy Creek fauna in the unrestricted sense. They state that the Grassy Creek fauna includes species which they term equivalent to those found in several zones in the Frasnian and Famennian in Europe. Müller & Müller correlate part of the Grassy Creek fauna with the upper part of the *Manticoceras*-Stufe (zone I) and the Independence formation of Iowa, and a younger part with either the *Cheiloceras*-Stufe (zone II) or *Platyclymenia*-Stufe (zone III–IV) and the Maple Mill shale of Iowa. They state that part of the Grassy Creek fauna may be still younger than the Maple Mill fauna.

Some of the Darby species are also represented in the Devonian faunas of Germany. On the basis of these species the Darby conodont fauna is tentatively correlated with zone V (*Clymenia*-Stufe) of the Famennian stage in Germany.

CONCLUSIONS

A relatively sparse (250 specimens) but fairly well preserved Upper Devonian conodont fauna has been studied from a black shale near the top of the Darby formation at two localities in the Wind River Mountains, Wyoming. Approximately 40 per cent of the specimens belong to the genera *Polygnathus* and *Spathognathodus*. *Palmatolepis*, *Icriodus*, and *Apatognathus*, which are characteristic of the Upper Devonian, are also represented. This fauna is correlated with part of the Saverton shale fauna of Missouri. The Saverton and Grassy Creek shales are distinct units. Most of the specimens described and illustrated by Branson & Mehl (1934) as Grassy Creek are actually from the Saverton. The Darby fauna is tentatively correlated with zone V (*Clymenia*-Stufe) of the Famennian stage in Germany.

ACKNOWLEDGMENTS

The field work for this study was completed in August, 1957, and the paper was written in the Department of Geology of the University of Kansas. I am indebted to Dr. Edward J. Zeller of the University of Kansas for his advice and aid in completing this study. Special gratitude is here expressed to Dr. Maurice G. Mehl of the University of Missouri for allowing me to examine the type collection there and for loaning me additional specimens from the Darby formation. I would also like to thank John S. Chapman who assisted me in the field and Donald B. McLaren for assistance in photographing the specimens. Alan J. Scott of the Illinois Geological Survey critically read the manuscript.

SYSTEMATIC DESCRIPTIONS

APATOGNATHUS VARIANS Branson & Mehl
Pl. 141, figs. 6,8

Apatognathus varians BRANSON & MEHL, 1934 (1933), Mo. Univ. Studies, v. 8, no. 3, p. 201, 202, pl. 17, figs. 1–3; BISCHOFF & ZIEGLER. 1956, Notizbl. hess. L.-Amt Bodenforsch., Bd, 84, p. 145, pl. 14, fig. 3.

This species is a sharply arched unit, having two limbs of about equal length which diverse slightly forming a narrow "V." The limbs are convex outward, denticulate, and barlike. The denticles are short, discrete and closely spaced, and project orally. The apical denticle is curved toward one limb of the arch and toward the oral face. The apical lamella joins the limbs at the apex on the aboral side and is moderately long.

Remarks.—*A. varians* differs from *A. inversa* Sannemann and *A. lipperti* Bischoff in having limbs which are convex outward.

Occurrence.—The type specimens of *A. varians* are from the Saverton (Grassy Creek of Branson & Mehl, 1934) shale of Missouri. Bischoff & Ziegler list its occurrence in Germany as zone V (Upper Devonian). Two specimens of *A. varians* have been found in the Darby formation, Bull Lake Creek, Wyoming.

Figured specimen.—USNM 137120.

HINDEODELLA cf. H. ACUTA Branson and Mehl
Pl. 141, fig. 10

Hindeodella acuta BRANSON & MEHL, 1934 (1933), Mo. Univ. Studies, v. 8, no. 3, p. 196, pl. 14, fig. 8; COOPER, 1939, Jour. Paleontology,

v. 13, p. 389,419, pl. 46, figs. 15,23,29; ——, 1945, Jour. Paleontology, v. 19, p. 614; YOUNGQUIST & PETERSON, 1947, Jour. Paleontology, v. 21, p. 245, pl. 38, figs. 7,8; MILLER & YOUNGQUIST, 1947, Jour. Paleontology, v. 21, p. 508,509, pl. 72, figs. 2,3, pl. 73, fig. 14; THOMAS, 1949, Geol. Soc. America Bull., v. 60, p. 411, pl. 3, fig. 31.

Hindeodella cf. *H. acuta* BRANSON & MEHL, 1934 (1933), Mo. Univ. Studies, v. 8, no. 3, p. 196, pl. 14, fig. 10.

The specimens doubtfully referred to *H. acuta* are not well enough preserved to show either the posterior or anterior termini.

Occurrence.—The type specimens of *H. acuta* are from the Saverton (Grassy Creek of Branson and Mehl, 1934) shale of Missouri. The species also occurs in a Bushberg-Hannibal horizon in Oklahoma, Sweetland Creek shale, Sheffield formation, and Prospect Hill siltstone of Iowa. Twenty-four fragmentary specimens have been found in the Darby formation, Bull Lake Creek, Wyoming, which are doubtfully referred to *H. acuta*.

Figured specimen.—USNM 137121.

ICRIODUS DARBYENSIS Klapper, n. sp.
Pl. 141, figs. 9,11,12

The outline of the oral surface is slender; the axis is slightly incurved at both ends. The denticulation consists of three longitudinal rows. The median row consists of five discrete conical denticles and a prominent posterior denticle (main cusp) distinctly set off at a 45° angle from the rest of the platform. The oral aspect of this species is dominated by the large posterior denticle. The median row is raised above the lateral rows.

The lateral rows consist of three discrete conical denticles, which do not project upward but diverge laterally. The lateral rows align with the median row. On the aboral side there is a deep basal excavation, especially at the posterior end where there is a prominent flaring of the aboral margins. In profile the oral and aboral edges are essentially parallel.

Remarks.—*I. darbyensis* resembles *I. cornutus* Sannermann, especially in aboral view. *I. cornutus* shows the lateral and median rows in alternating series, a straight platform not incurved at either end, and a prominent downcurving of the posterior aboral surface. Also, the main cusp is more distinctly set off from the platform in *I. darbyensis*.

I. darbyensis also resembles *I. rectus* Youngquist & Peterson in that the lateral rows appear to converge anteriorly. *I. darbyensis* has a more prominent main cusp set off from the rest of the platform and a basal excavation which continues almost the entire length of the platform.

Occurrence.—Six specimens of *I. darbyensis* have been found in the Darby formation, Bull Lake Creek, Wyoming. The genus *Icriodus* is restricted to the Devonian.

Types.—Holotype USNM 136672.

ICRIODUS MEHLI Klapper, n. sp.
Pl. 141, figs. 2,3

The oral outline is rectangular. The denticles are arranged in three longitudinal rows. The median row consits of about eight discrete denticles, which are circular in cross section. The median row denticles rise slightly above the lateral rows. Each lateral row consists of about seven discrete denticles which are transversely oval in shape.

EXPLANATION OF PLATE 141

All specimens are from a black shale four feet below the top of the Darby formation, south side of Bull Lake Creek, Wind River Mountains, Wyoming. All figures are unretouched photographs ×50.

FIG. *1*—*Neoprioniodus* sp. USNM 136671.

2,3—*Icriodus mehli*, n. sp. Holotype USNM 136673; *2*, aboral view; *3*, oral view.

4,5—*Icriodus* sp. USNM 136674; *4*, oral view; *5*, aboral view.

6,8—*Apatognathus varians* Branson & Mehl. USNM 137120; *6*, aboral view; *8*, oral view.

7—*Ozarkodina regularis* Branson & Mehl. USNM 137122; inner lateral view.

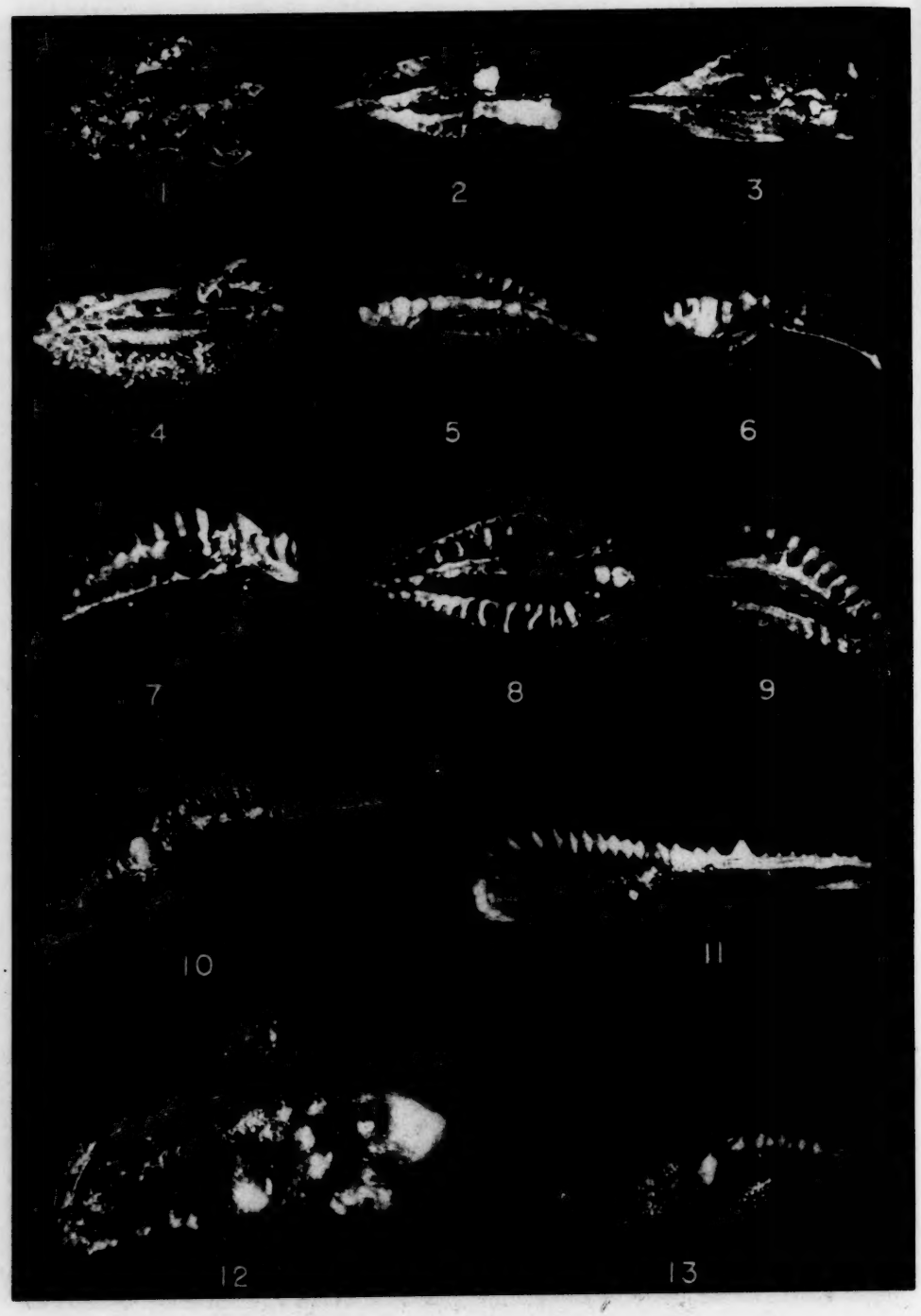
9,11,12—*Icriodus darbyensis*, n. sp. Holotype USNM 136672; *9*, oral-lateral view; *11*, oral view; *12*, lateral view.

10—*Hindeodella* cf. *H. acuta* Branson & Mehl. USNM 137121; lateral view.

13—*Spathognathodus aculeatus* (Branson & Mehl). USNM 137130; lateral view.

14—*Spathognathodus jugosus* (Branson & Mehl). USNM 137131; lateral view.

1
2
3
4
5
6
7
8
9
10
11
12
13
14


1
2
3
4
5
6
7
8
9
10
11
12
13

The lateral denticles are in alternating series with the median row denticles, except for the anterior two which are aligned.

The unusual feature of this species is the aboral surface. Unlike all previously described species of *Icriodus*, *I. mehli* does not possess a basal excavation. There is only a narrow, shallow groove anteriorly, broadening posteriorly. The aboral margins do not flare backward as is also characteristic of this genus. Since there is no flaring of the margins, the aboral surface occupies about one-third of the area occupied by the oral surface.

Remarks.—In most respects *I. mehli* has the characteristics typical of *Icriodus*. However, this species is unlike all others of the genus due to the nature of the aboral surface.

Occurrence.—One well preserved specimen of *I. mehli* has been found in the Darby formation, Bull Lake Creek, Wyoming.

Types.—Holotype USNM 136673.

ICRIODUS sp.
Pl. 141, figs. 4,5

An additional specimen from the Darby fauna is also referred to the genus *Icriodus*. It appears to resemble *I. alternatus* but is not rounded posteriorly, is wider in outline, and its aboral excavation is narrower.

Occurrence.—Darby formation, Bull Lake Creek, Wyoming.

Figured specimen.—USNM 136674.

NEOPRIONIODUS sp.
Pl. 141, fig. 1

Three specimens from the Darby fauna are referred to this genus established by Rhodes & Müller (1956).

Occurrence.—Darby formation, Bull Lake Creek, Wyoming.

Figured specimen.—USNM 136671.

OZARKODINA REGULARIS Branson & Mehl
Pl. 141, fig. 7

Ozarkodina regularis BRANSON & MEHL, 1934 (1933), Mo. Univ. Studies, v. 8, no. 4, p. 287, pl. 23, figs. 13,14; BRANSON, 1938, Mo. Univ. Studies, v. 13, no. 3, p. 181; BRANSON & MEHL, 1938, Mo. Univ. Studies, v. 13, no. 4, pl. 33, fig. 32; COOPER & SLOSS, 1943, Jour. Paleontology, v. 17, p. 170, pl. 29, fig. 12; SANNEMANN, 1955b, Senck, leth., Bd. 36, p. 133, pl. 6, figs. 3,5–7; BISCHOFF, 1956, Notizbl. hess. L.-ant Bodenforsch., Bd. 84, p. 127; BISCHOFF & ZIEGLER, 1956, Notizbl. hess. L.-Amt Bodenforsch., Bd. 84, p. 152; BISCHOFF, 1957, Abh. hess. L.-Amt. Bodenforsch., no. 19, p. 9,10,40,63.

Ozarkodina cf. *O. regularis* THOMAS, 1949, Geol. Soc. America Bull., v. 60, p. 408, pl. 2, fig. 11.

The blade is thin and highly arched, with a broad flexure at the apex. Each limb is concave inward. There are about nine anterior limb denticles which are posteriorly inclined, which increase in size nearer the arch apex, and have edges in contact nearly to the pointed apices. The apical denticle is twice as wide as the limb denticles and is inclined posteriorly. There are about eleven posterior limb denticles which are inclined posteriorly and are similar to those of the anterior series. Several germ denticles are suppressed in the posterior limb. The aboral edge is sharp.

Remarks.—These specimens compare favorably with the type specimens of *O. regularis*.

EXPLANATION OF PLATE 142

All specimens from a black shale four feet below the top of the Darby formation, south side of Bull Lake Creek, Wind River Mountains, Wyoming. All figures are unretouched photographs ×50.

FIG. *1*—*Polygnathus varinodosa* Branson & Mehl. USNM 137129; oral view.
2,3—*Polygnathus inornata* E. R. Branson. USNM 137126; *2*, oral view; *3*, aboral view.
4—*Polygnathus nodocostata* Branson & Mehl. USNM 137127; oral view.
5,6—*Polygnathus wyomingensis*, n. sp. Paratype C141-4, University of Missouri; *5*, oral view; *6*, lateral view.
7,8—*Polygnathus wyomingensis*, n. sp. Holotype USNM 136675; *7*, lateral view; *8*, oral view.
9—*Polygnathus triangularis* Branson & Mehl. USNM 137128; oral view.
10, 11—*Palmatolepis* (*Palmatolepis*) *gonioclymeniae* Müller. USNM 137123; *10*, oral view; *11*, lateral view.
12—*Palmatolepis* (*Palmatolepis*) *rugosa* (Branson & Mehl). USNM 137125; oral view.
13—*Palmatolepis* (*Palmatolepis*) *gonioclymeniae* Müller. USNM 137124; Oral view of specimen with broken tip, fitted to plate.

Occurrence.—The type specimens are from the Bushberg sandstone of Missouri. Other occurrences are in the Madison group, Alberta, and the Maple Mill shale of Iowa (*Ozarkodina* cf. *O. regularis*). Nine specimens of *O. regularis* have been found in the Darby formation, Bull Lake Creek, Wyoming. Sannemann reported this species from the *Cheiloceras*-Stufe in Germany, Bischoff and Ziegler listed its range as zone Iγ-zone V (U. Dev.), and Bischoff reported *O. regularis* from the Gattendorfia-Stufe (cu I, Mississippian). Although its occurrence in the Maple Mill shale was not positively established, the fact that it is now known to occur in the Darby would indicate that its range in this country is from Upper Devonian to Lower Mississippian.

Figured specimen.—USNM 137122.

PALMATOLEPIS (PALMATOLEPIS) GONIOCLYMENIAE Müller
Pl. 142, figs. 10,11,13

?*Palmatolepis* sp. BRANSON & MEHL, 1941, Denison Univ. Bull., Jour. Sci. Lab., v. 35, pl. 7, fig. 6.

Palmatolepis (*Palmatolepis*) *gonioclymeniae* MÜLLER, 1956a, Abh. Senckenb. Naturf. Ges., v. 494, p. 16,17,26,27,35,36,38,39,42, pl. 7, figs. 12,16–19; MÜLLER & MÜLLER, 1957, Jour. Paleontology, v. 31, p. 1100.

Palmatolepis gracilis BISCHOFF, 1957, Abh. hess. L.-Amt Bodenforsch., no. 19, p. 41,42, pl. 6, fig. 6.

The plate is small, slender, and long. The posterior end of the plate is slightly upcurved. The outer part of the plate is as large or larger than the inner part. The carina is low posteriorly, consisting of about six or seven small nodes, extending almost to the tip of the plate. Anterior to the azygous node, the carina is deflected inwardly about 30° from the axis, giving the axis a gently curved pattern. Anteriorly the carina passes into the high blade as the nodes flatten into denticles. Aborally the keel shows a sigmoidal twist at the azygous node. The keel is low posteriorly, except near the tip, but high anteriorly.

Remarks.—*P. gonioclymeniae* is distinct from *P. gracilis* Branson & Mehl. *P. gracilis* has an extremely narrow plate, which is not developed on the sides of the blade and which flares into two small lateral lobes in the region of the azygous node. However, the outer lateral lobe is not always developed and, in any case, the inner lateral lobe is larger than the outer lobe. In contrast, the outer part of the plate is as large or larger than the inner part in *P. gonioclymeniae*. *P. gonioclymeniae* has a wider plate which is partly developed on the sides of the blade.

It should be noted that Branson & Mehl (1934, p. 238,256) "doubtfully referred to *P. gracilis*" the specimens illustrated as figures 2 and 5 (pl. 18), implying that figure 8 represents the holotype of *P. gracilis* although they did not designate it as such. Since Branson & Mehl state that figures 2 and 5 probably represent "two species, both distinct from *P. gracilis*," the specimen illustrated as figure 8 (Branson & Mehl, 1934, pl. 18) is hereby designated the holotype of *P. gracilis*.

Occurrence.—The type specimen is from the upper part of zone V or zone VI in Effenberg bei Hachen. Other specimens are from the Karnic Alps (zone V or VI) and Bicken, Blatt Ballersbach (zone V or VI). Fifteen specimens of *P. gonioclymeniae* have been found in the Darby formation, Bull Lake Creek, Wyoming. In general the genus *Palmatolepis* is restricted to the Upper Devonian.

Figured specimens.—USNM 137123, 137124.

PALMATOLEPIS (PALMATOLEPIS) RUGOSA Branson & Mehl
Pl. 142, fig. 12

Palmatolepis rugosa BRANSON & MEHL, 1934 (1933), Mo. Univ. Studies, v. 8, no. 3, p. 236, pl. 18, figs. 15,16,18,19; HASS, 1947, Jour. Paleontology, v. 21, p. 134,135; SANNEMANN, 1955a, Neues Jb. Geol. u. Paläontol., Abh. 100, p. 326,331, pl. 24, fig. 10; BISCHOFF & ZIEGLER, 1956, Notizbl. hess. L.-Amt. Bodenforsch., Bd. 84, p. 155; HASS, 1956, U. S. Geol. Survey Prof. Paper 286, p. 17,21,22; CLOUD, BARNES, & HASS, 1957, Geol. Soc. America Bull., v. 68, pl. 4, fig. 11.

Palmatolepis (*Palmatolepis*) *rugosa* MÜLLER, 1956a, Abh. Senckenb. Naturf. Ges., v. 494, p. 16,17,29.

This species has a sigmoidally curved plate. The carina is without denticles. A row of nodes parallels the carina on the inner side of the plate. Posteriorly, on the outer side of the plate, there is a series of short ridges normal to the carina. Anteriorly the ridges become nodes similar to those on the inner side. The aboral surface is

marked by ridges and furrows more or less normal to the keel.

Remarks.—This distinctive species of *Palmatolepis* is somewhat similar to *P. quadrantinodosa*. However, *P. quadrantinodosa* has no ridges on the outer side of the plate, no nodes on the inner side, and a denticulate carina. The Darby specimens of *P. rugosa* are fragmentary but display the features characteristic of this species.

Occurrence.—The type specimens are from the Saverton (Grassy Creek of Branson & Mehl, 1934) shale of Missouri. Other occurrences are a shale at Bedford, Illinois, the Huron and lower Ohio shales of Ohio, the Gassaway member of the Chattanooga shale of Tennessee, and the Houy formation of Texas. Eleven specimens of *P. rugosa* have been found in the Darby formation, Bull Lake Creek, Wyoming. Its range in Germany is given as zone IIIβ–IV, and possibly the lowest part of zone V (Sannemann, 1955a, p. 326).

Figured specimen—USNM 137125.

POLYGNATHUS INORNATA E. R. Branson
Pl. 142, figs. 2,3

Polygnathus inornata E. R. BRANSON, 1934 (1933), Mo. Univ. Studies, v. 8, no. 4, p. 309, pl. 25, figs. 8,26; BRANSON & MEHL, 1934 (1933), Mo. Univ. Studies, v. 8, no. 4, p. 293, pl. 24, figs. 5–7; KNECHTEL & HASS, 1938, Jour. Paleontology, v. 12, p. 519; COOPER, 1939, Jour. Paleontology, v. 13, p. 400,420, pl. 39, figs. 11,12; HASS, 1943, Jour. Paleontology, v. 17, p. 308; YOUNGQUIST & PATTERSON, 1949, Jour. Paleontology, v. 23, p. 64, pl. 17, figs. 4, 5,9,13; THOMAS, 1949, Geol. Soc. America Bull., v. 60, p. 409,411, pl. 3, fig. 36; YOUNGQUIST & DOWNS, 1951, Jour. Paleontology, v. 25, p. 787,788, pl. 111, figs. 11,17,18; BISCHOFF & ZIEGLER, 1956, Notizbl. hess. L.-Amt Bodenforsch, Bd. 84, p. 157, pl. 12, figs. 4,5; HASS, 1956, U. S. Geol. Survey Prof. Paper 286, p. 25, pl. 2, figs. 14,15; BISCHOFF, 1957, Abh. hess. L.-Amt Bodenforsch., no. 19, p. 11–14,42,63, pl. 2, fig. 17,18,20,21; CLOUD, BARNES & HASS, 1957, Geol. Soc. America Bull., v. 68, p. 813, pl. 5, fig. 6.

The axis is slightly downcurved posteriorly. Anteriorly the margins are bent upward almost vertically; posteriorly they are slightly bent upward. The posterior end is continued beyond the plate and is sharply pointed. The plate is marked by transverse ridges which extend from the margins about halfway to the carina. The carina is nodose. The aboral surface is marked by a small escutcheon anteriorly and a sharp keel posteriorly.

Remarks.—*P. inornata* closely resembles *P. lobata*, but mature specimens of *P. lobata* have a lobe on the outer margin of the plate. The Darby specimens are smaller than most representatives of *P. inornata*, but are identical in other respects.

Occurrence.—The type specimens are from the Hannibal formation of Missouri. Other occurrences are in the Bushberg and Chouteau formations of Missouri, a Bushberg-Hannibal horizon in Oklahoma, a thin shale at the base of the Lodgepole limestone of Montana, the Wassonville dolomite, Prospect Hill and English River formations of Iowa, Maury formation of Tennessee, and the Houy formation of Texas. Two specimens of *P. inornata* have been found in the Darby formation, Bull Lake Creek, Wyoming. Its range in Germany is listed as zone IIIα–cuIIIα. The presence of this long ranging species in the Darby formation is its first American Devonian occurrence.

Figured specimen.—USNM 137126.

POLYGNATHUS NODOCOSTATA Branson & Mehl
Pl. 142, fig. 4

Polygnathus nodocostata BRANSON & MEHL, 1934 (1933), Mo. Univ. Studies, v. 8, no. 3, p. 246, 247, pl. 20, figs. 9–13, pl. 21, fig. 15; GROHSKOPF, CLARK & ELLISON, 1943, Mo. Geol. Survey and Water Res., 62nd Bien. Rept., App. 4, p. 16,17, pl. 2, figs. 14,16; CLARK, BRANSON & MEHL, and BRANSON, respectively, 1944, *in* Branson, Mo. Univ. Studies, v. 19, no. 3, p. 155,163,173; CAMPBELL, 1946, Geol. Soc. America Bull., v. 57, p. 845; BOND, 1947, Ohio Jour. Sci., v. 47, p. 21,33, pl. 2, fig. 22.

The plate is elliptical in outline and is covered orally by five longitudinal rows of tubercles. The straight carina is the middle row of tubercles which are the same size as those of the plate, excepting the anterior four or five, which are larger and form the blade.

Remarks.—This species is distinguished by its low median carina and its longitudinal rows of tubercles. As pointed out by Branson & Mehl, it resembles *P. rhomboidea* Ulrich & Bassler, but *P. rhomboidea* has longitudinal rows of tubercles only in the anterior part of the plate and the carina is not tuberculate throughout its length.

Occurrence.—The type specimens are from the Saverton (Grassy Creek of Branson & Mehl, 1934) shale of Missouri. Other occurrences are in the Fortune and Louisiana formations of Missouri, lower Blackiston formation of Indiana, and the lower Ohio shale of Ohio. Three specimens of *P. nodocostata* have been found in the Darby formation, Bull Lake Creek, Wyoming.

Figured specimen.—USNM 137127.

POLYGNATHUS TRIANGULARIS
Branson & Mehl
Pl. 142, fig. 9

Polygnathus triangularis BRANSON & MEHL, 1934 (1933), Mo. Univ. Studies, v. 8, no. 3, p. 247, pl. 21, figs. 16,20; BRANSON & MEHL, and BRANSON, respectively, 1944, *in* Branson, Mo. Univ. Studies, v. 19, no. 3, p. 166,173; CAMPBELL, 1946, Geol. Soc. America Bull., v. 57, p. 844; YOUNGQUIST & PETERSON, 1947, Jour. Paleontology, v. 21, p. 251,252; MILLER & YOUNGQUIST, 1947, Jour. Paleontology, v. 21, p. 515; THOMAS, 1949, Geol. Soc. America Bull., v. 60, p. 407,408,411, pl. 2, fig. 30; BISCHOFF, 1957, Abh. hess. L.-Amt Bodenforsch., no. 19, p. 13,44,63.

Polygnathus triangulatus SLOSS & LAIRD, 1945, U. S. Geol. Survey Oil and Gas Inv., Prelim. Chart 15; COOPER, 1945, Jour. Paleontology, v. 19, p. 613,614, pl. 84, fig. 17.

In oral view the plate is subtriangular in outline. The plate is ornamented by strong transverse ridges. The carina is slightly to one side of the median position, is flanked by fairly deep furrows, and is incurved posteriorly. Aborally there is a sharp keel posteriorly.

Remarks.—This species is characterized by its subtriangular outline, its strong transverse ridges and the position of the carina which is offset slightly from the median. It differs from *P. sheffieldensis* which is not subtriangular in outline.

Occurrence.—The type specimens are from the Saverton (Grassy Creek of Branson & Mehl, 1934) shale of Missouri. Other occurrences are in the Louisiana limestone of Missouri, the Glenn Creek-White Ridge member of the "Jefferson" formation of Montana, basal Blackiston formation of Indiana, English River siltstone and the Maple Mill shale of Iowa. Four specimens of *P. triangularis* have been found in the Darby formation, Bull Lake Creek, Wyoming. It has been reported from the *Pericyclus*-Stufe (cuII) in Germany.

Figured specimen.—USNM 137128.

POLYGNATHUS VARINODOSA
Branson & Mehl
Pl. 142, fig. 1

Polygnathus varinodosa BRANSON & MEHL, 1934 (1933), Mo. Univ. Studies, v. 8, no. 3, p. 249, pl. 20, fig. 15, pl. 21, figs. 9,11,12,18; BRANSON & MEHL, and BRANSON, respectively, 1944, *in* Branson, Mo. Univ. Studies, v. 19, no. 3, p. 166,173; CAMPBELL, 1946, Geol. Soc. America Bull., v. 57, p. 846; YOUNGQUIST & PETERSON, Jour. Paleontology, v. 21, p. 252, pl. 38, fig. 10.

The plate is thick; the posterior end is slightly turned to one side. The carina extends the length of the plate and is moderately high except posteriorly where it is low. Anteriorly there is a distinctive and prominent notch to one side of the blade. The oral surface is strongly rugose. Aborally there is a pronounced median keel extending the length of the plate. There is no escutcheon.

Remarks.—This species is quite distinctive and only superficially resembles *P. retrorsa*, *P. papillata*, and *P. verrucosa*, all from the Sheffield formation. In *P. retrorsa* the carina and plate are sharply recurved posteriorly. In *P. papillata* the carina does not exist posteriorly and the oral surface is nodose rather than rugose. The carina is not pronounced in *P. verrucosa*.

Occurrence.—The type specimens are from the Saverton (Grassy Creek of Branson & Mehl, 1934) shale of Missouri. Other occurrences are in the Louisiana limestone of Missouri, the lower Blackiston formation of Indiana, and the Sheffield formation of Iowa. Two specimens of *P. varinodosa* have been found in the Darby formation, Bull Lake Creek, Wyoming.

Figured specimen.—USNM 137129.

POLYGNATHUS WYOMINGENSIS
Klapper, n. sp.
Pl. 142, figs. 5–8

In profile this species is arched and the posterior end is sharply downcurved. The plate is almost symmetrical and the carina is nearly straight or slightly incurved at the posterior end. The carina is nodose and extends almost to the posterior tip. The plate bears prominent transverse ridges. The blade consists of laterally compressed denticles. A trough exists on both sides of the fixed part of the blade. Aborally there is a small escutcheon anteriorly which is distinctively elongated and a keel from the escutcheon to the posterior tip.

Remarks.—This species is distinguished by its down-curved posterior end and its almost symmetrical plate. *P. wyomingensis* has a carina which is nearly straight to slightly incurved. In contrast, *P. normalis* Miller & Youngquist has a strongly asymmetrical plate with a sharply incurved carina.

Occurrence.—Eight specimens of *P. wyomingensis* have been found in the Darby formation, Bull Lake Creek, Wyoming.

Types.—Holotype USNM 136675; two paratypes C141-4, University of Missouri.

SPATHOGNATHODUS ACULEATUS (Branson & Mehl) Pl. 141, fig. 13

Spathodus aculeatus BRANSON & MEHL, 1934 (1933), Mo. Univ. Studies, v. 8, no. 3, p. 186, 187, pl. 17, figs. 11,14, no. 4, p. 274.
Spathognathodus aculeatus HASS, 1947, Jour. Paleontology, v. 21, p. 134,135,140; ——, 1956, U. S. Geol. Survey Prof. Paper 286, p. 17,22,24.

The blade is thin and straight. The large navel is at or slightly behind midlength, is wide and not elongate, and its margins are formed by abrupt lateral expansions. The oral denticulation is irregular and consists of more than fourteen denticles. At midlength there are about four denticles that stand out on the inner side of the blade and are connected by short ridges to the main row of denticles. Some germ denticles are present.

Remarks.—*S. aculeatus* was compared by Branson & Mehl to *S. sulciferus* but they noted that *S. sulciferus* has a thicker blade and a more elongate navel having lateral margins formed by a widening of the lower part of the blade rather than an abrupt expansion. The denticles that form the inner row are only in the posterior half of the blade and not on both sides of the navel as they are in *S. aculeatus*.

Occurrence.—The type specimens are from the Saverton (Grassy Creek of Branson & Mehl, 1934) shale of Missouri. Other occurrences are in the Cleveland and upper Ohio shales of Ohio, the Glen Park limestone of Missouri, the top black shale of the Gassaway member of the Chattanooga shale and the basal Maury formation of Tennessee. Twenty-five specimens of *S. aculeatus* have been found in the Darby formation, Bull Lake Creek, Wyoming.

Figured specimen.—USNM 137130.

SPATHOGNATHODUS JUGOSUS (Branson & Mehl) Pl. 141, fig. 14

Spathodus jugosus BRANSON & MEHL, 1934 (1933), Mo. Univ. Studies, v. 8. no. 3, p. 187, 189–191, pl. 17, figs. 19,22.
Spathognathodus jugosus BISCHOFF & ZIEGLER, 1956, Notizbl. hess. L.-Amt Bodenforsch., Bd. 84, p. 167, pl. 13, figs. 8–10.

The oral outline of the blade is slightly curved. The posterior half of the aboral edge is slightly arched. The navel is extremely long, extending from near the posterior end anteriorly two-thirds the length of the blade. The lateral flare from the navel is thin. Oral denticles are numerous and pointed. Anteriorly germ denticles are present.

Remarks.—The specimens from the Darby fauna compare favorably with the types of *S. jugosus* except for the thinner appearance of the blade posteriorly in oral view. The denticles do not appear as ridges posteriorly but as points in the Darby specimens. However, these specimens, like the type specimens of *S. jugosus*, are differentiated from all other species of *Spathognathodus* by their extremely long navels.

Occurrence.—The type specimens are from the Saverton (Grassy Creek of Branson & Mehl, 1934) shale of Missouri. Twelve specimens of *S. jugosus* have been found in the Darby formation, Bull Lake Creek, Wyoming. It is abundant in zone V in Germany, but there is an isolated occurrence in the *Pericyclus*-Stufe (cuII).

Figured specimen.—USNM 137131.

REFERENCES

ANDRICHUK, JOHN M., 1956, Devonian in northwestern Wyoming: Wyo. Geol. Assoc., 11th Ann. Field Conference, Guidebook, Jackson Hole, Wyoming, p. 43–49.

BECKMANN, HEINZ, 1949, Conodonten aus dem Iberger Kalk (Ober-Devon) des Bergischen Landes und ihr Feinbau: Senckenbergiana, v. 30, p. 153–168, pls. 1–4.

BISCHOFF, GÜNTER, 1956, Oberdevonische Conodonten (to Iδ) aus dem Rheinischen Schiefergebirge: Notizbl. hessischen L.-Amt Bodenforschung, Bd. 84, p. 115–137, pls. 8–10.

——, 1957, Die Conodonten-Stratigraphie des rhenoherzynischen Unterkarbons mit Berücksichtigung der Wocklumeria-Stufe und der Devon/Karbon-Grenze: Abh. hessischen L.-Amt Bodenforschung, no. 19, p. 1–64, pls. 1–6.

——, and ZIEGLER, WILLI, 1956, Daz Alter der "Urfer Schicten" im Marburger Hinterland nach Conodonten: Notizbl. hessischen L.-Amt Bodenforschung, v. 84, p. 138–169, pls. 11–14.

BLACKWELDER, ELIOT, 1918, New geological formations in western Wyoming: Wash. Acad. Sci. Jour., v. 8, p. 420–421.

BOND, RALPH H., 1947, Ohio shale conodonts: Ohio Jour. Sci., v. 47, p. 21–37, pls. 1,2.

BRANSON, E. B., 1938, Stratigraphy and paleontology of the Lower Mississippian of Missouri, Part I: Mo. Univ. Studies, v. 13, no. 3, p. 1–205, pls. 1–20.

——, *et al.*, 1938, Stratigraphy and paleontology of the Lower Mississippian of Missouri, Part II: Mo. Univ. Studies, v. 13, no. 4, p. 1–252, pls. 21–48.

——, 1944, The Geology of Missouri: Mo. Univ. Studies, v. 19, no. 3, p. 1–495, pls. 1–49.

—— & BRANSON, C. C., 1941, Geology of Wind River Mountains, Wyoming: Am. Assoc. Petroleum Geologists Bull., v. 25, no. 1, p. 120–151.

—— & MEHL, M. G., 1934 (1933), Conodont studies no. 3, Conodonts from the Grassy Creek shale of Missouri: Mo. Univ. Studies, v. 8, no. 3, p. 171–259, pls. 13–21.

——, ——, & BRANSON, E. R., 1934 (1933), Conodont studies no. 4, Conodonts from the Bushberg sandstone and equivalent formations of Missouri; Conodonts from the Hannibal formation of Missouri: Mo. Univ. Studies, v. 8, no. 4, p. 265–343, pls. 22–28.

—— & MEHL, M. G., 1938, The conodont genus *Icriodus* and its stratigraphic distribution: Jour. Paleontology, v. 12, p. 156–166, pl. 26.

—— & ——, 1941, A record of typical American conodont genera in various parts of Europe: Denison Univ. Bull., J. Sci. Lab., vol. 35, p. 189–194, pl. 7.

—— & ——, 1944, Conodonts *in* Shimer and Shrock, Index fossils of North America, Chapter 7, p. 235–246, pls. 93,94.

BRYANT, WILLIAM L., 1921, The Genessee conodonts: Bull. Buff. Soc. Nat. Sci., v. 13, no. 2, p. 1–59, pls. 1–16.

CAMPBELL, GUY, 1946, New Albany shale: Geol. Soc. America Bull., v. 57, p. 829–908, pls. 1–3.

COOPER, CHALMER L., 1939, Conodonts from a Bushberg-Hannibal horizon in Oklahoma: Jour. Paleontology, v. 13, p. 379–422, pls. 39–47.

——, 1945, Devonian conodonts from northwestern Montana: Jour. Paleontology, v. 19, p. 612–615, pl. 84.

—— & SLOSS, L. L., 1943, Conodont fauna and distribution of a Lower Mississippian black shale in Montana and Alberta: Jour. Paleontology, v. 17, p. 168–176, pls. 28,29.

COOPER, G. A., *et al.*, 1942, Correlation of the Devonian sedimentary formations of North America: Geol. Soc. America Bull., v. 53, p. 1729–1794.

CLOUD, P. E., JR., BARNES, V. E., and HASS, W. H., 1957, Devonian-Mississippian transition in central Texas: Geol. Soc. America Bull., v. 68, p. 807–816, pls. 4,5.

ELLISON, SAMUEL P., JR., 1950, Subsurface Woodford black shale, West Texas and Southeast New Mexico: Texas Univ. Bureau of Econ. Geol., Report of Inv., no. 7, p. 1–17, pls. 1–3.

——, & GRAVES, ROY W., JR., 1941, Lower Pennsylvanian (Dimple limestone) conodonts of the Marathon region, Texas: Univ. Mo. Sch. Min. and Met. Bull., Tech. Ser., v. 14, no. 3, p. 1–13, pls. 1–3.

FAY, ROBERT O., 1952, Catalogue of conodonts: Kansas Univ. Pal. Contr., Vertebrata, Art. 3, p. 1–206.

GROHSKOPF, J. G., CLARK, E. L., & ELLISON, S., 1943, The Fortune, a new Devonian formation in southwestern Missouri: Mo. Geol. Survey and Water Res., 62nd Bien. Rept., App. 4, p. 5–17, pl. 2.

HASS, WILBERT H., 1943, Corrections to the Kinderhook conodont faunas, Little Rocky Mountains, Montana: Jour. Paleontology, v. 17, p. 307–309.

——, 1947, Conodont zones in Upper Devonian and Lower Mississippian formations of Ohio: Jour. Paleontology, v. 21, p. 131–141.

——, 1956, Age and correlation of the Chattanooga shale and the Maury formation: U. S. Geol. Survey Prof. Paper 286, p. 1–47, pls. 2–5.

HUDDLE, JOHN W., 1934, Conodonts from the New Albany shale of Indiana: Bull. Amer. Paleont., v. 21, no. 72, p. 187–325, pls. 1–12.

KNECHTEL, M. M., & HASS, WILBERT H., 1938, Kinderhood conodonts from Little Rocky Mountains, northern Montana: Jour. Paleontology, v. 12, p. 518–520.

MILLER, A. K., & YOUNGQUIST, WALTER, 1947, Conodonts from the type section of the Sweetland Creek shale in Iowa: Jour. Paleontology, v. 21, p. 501–517, pls. 72–75.

MÜLLER, KLAUS J., 1956a, Zur Kenntnis der Conodonten-Fauna des europäischen Devons, 1. Die Gattung *Palmatolepis:* Abh. Senckenb. Naturf. Ges., v. 494, p. 1–69, pls. 1–11.

——, 1956b, Taxonomy, nomenclature, orientation, and stratigraphic evaluation of conodonts: Jour. Paleontology, v. 30, p. 1324–1340, pl. 145.

——, & MÜLLER, EVA M., 1957, Early Upper Devonian (Independence) conodonts from Iowa, Part I: Jour. Paleontology, v. 31, p. 1069–1108, pls. 135–142.

RHODES, F. H. T., & MÜLLER, KLAUS J., 1956, The conodont genus *Prioniodus* and related forms: Jour. Paleontology, v. 30, p. 695–699.

SANNEMANN, DIETRICH, 1955a, Beitrag zur Untergliederung des Oberdevons nach Conodonten: Neues Jb. Geol. u. Paläontol., Abh 100, p. 324–331, pl. 24.

——, 1955b, Oberdevonische Conodonten (to IIα): Senckenbergiana lethaea, Bd. 36, p. 123–156, pls. 1–6.

SLOSS, L. L., & LAIRD, W. M., 1945, Mississippian and Devonian stratigraphy of northwestern Montana: U. S. Geol. Survey Oil and Gas Inv., Prelim. Chart 15.

STAUFFER, CLINTON R., 1938, Conodonts of the Olentangy shale: Jour. Paleontology, v. 12, p 411–443, pls. 48–53.

THOMAS, HORACE D., 1948, Summary of Paleozoic stratigraphy of the Wind River Basin, Wyoming: Wyo. Geol. Assoc., 3rd Ann. Field Conference, Guidebook, Wind River Basin, Wyoming, p. 84–85.

THOMAS, LEO A., 1949, Devonian-Mississippian formations of southeast Iowa: Geol. Soc. America Bull., v. 60, p. 403–437, pls. 1–4.

ULRICH, E. O., & BASSLER, RAY S., 1926, A Classification of the toothlike fossils, conodonts, with descriptions of American Devonian and Mississippians species: U. S. Nat. Mus. Proc., v. 68, art. 12, no. 2613, p. 1–63, pls. 1–11.

YOUNGQUIST, WALTER, & DOWNS, H. R., 1951, Conodonts from the Lower Mississippian Wassonville dolomite of Iowa: Jour. Paleontology, v. 25, p. 785–792, pl. 111.

——, & MILLER, A. K., 1948, Additional conodonts from the Sweetland Creek shale of Iowa: Jour. Paleontology, v. 22, p. 440–450, pls. 67–68.

——, & PATTERSON, S. H., 1949, Conodonts from the Lower Mississippian Prospect Hill sandstone of Iowa: Jour. Paleontology, v. 23, p. 57–73, pls. 15–17.

——, & PETERSON, RICHARD F., 1947, Conodonts from the Sheffield formation of north-central Iowa: Jour. Paleontology, v. 21, p. 242–253, pls. 36–38.

ZIEGLER, WILLI, 1956, Unterdevonische Conodonten, insbesondere aus dem Schönauer und dem Zorgensis-Kalk: Notizbl. hessischen L.-Amt Bodenforsch., Bd. 84, p. 93–106, pls. 6–7.

JOURNAL OF PALEONTOLOGY, V, 32, NO. 6, P. 1094–1106, 33 TEXT-FIGS., NOVEMBER 1958

NOVOJILOV'S CLASSIFICATION OF FOSSIL CONCHOSTRACANS —A CRITICAL EVALUATION. PART I. FAMILY LEAIIDAE

PAUL TASCH
University of Wichita, Kansas

ABSTRACT—In 1956, Tasch set forth three principles for use in the classification of fossil conchostracans. Two additional principles are here formulated and illustrated. *Principle 4* states that a broad range of shell outline is to be expected in populations of living and fossil conchostracans referable to the same genus. Therefore genera erected on the basis of one or few specimens, where shell outline is the primary distinction, are invalid. *Principle 5* states that reassignments of genera and species based only on inadequate descriptions and illustrations by the original author are of doubtful value and should be considered invalid.

Utilizing the five principles now established, Novojilov's classification of fossil conchostracans is critically examined. Such analysis shows the ten subfamilies erected by Novojilov to be largely based on genera shown to be synonyms of existing genera. All ten subfamilies, Leaiinae, Cycloleaiinae, Lioleaiinae, Amphikoilinae, Monoleiolophinae, Hemicycloleaiinae, Igorvarentsoviinae, Rostroleaiinae, Praeleaiinae, and Estheriellinae are therefore rejected.

Similarly the genera, *Dolicholeaia* Novojilov, *Leainella* Novojilov, *Kaltanleaia* Novojilov, *Mimoleaia* Novojilov, *Brachiorrhynchia* Novojilov *Australoleaia* Novojilov, *Gonioleaia* Novojilov, *Bileaia* Kobayashi, *Tataroleaia* Novojilov, *Symmetroleaia* Novojilov, *Kargalia* Novojilov, *Lioleaia* Novojilov, *Lioleaiina* Novojilov, *Jaxartus* Novojilov, *Inkus* Novojilov, *Siberoleaia* Novojilov, *Igorvarentsovia* Novojilov, *Falsirostria* Novojilov, *Granirostria* Novojilov, *Teiichium* Novojilov, *Mesoleaia* Kobayashi, *Pseudoestheriella* Novojilov, *Tancrediella* Novojilov, and *Palermisca* Novojilov are rejected.

INTRODUCTION

IN 1956 Tasch formulated three broad principles in an attempt to place the classification of fossil conchostracans on a more meaningful and less subjective basis. It has since become obvious that several additional principles are needed to set further limits on certain arbitrary procedures used by workers in assigning fossil conchostracans to newly erected genera, subfamilies, etc. These added principles will be indicated and discussed as a preliminary to a critical review of Novojilov's complicated treatment of the family Leaiidae.

It may be observed that the existence of the iron curtain created conditions where students of fossil conchostracans in different countries (Japan and Russia, for example) were independently reclassifying fossil material as determined solely from published accounts without contact or knowledge of what other workers had done or were doing in this regard. Thus, in 1954 Kobayashi, using type specimens described in the literature, erected three new genera of the Leaiidae. However, in 1952 Novojilov, using the identical types, also determined solely from published accounts, had erected three new genera. Kobayashi's "new" genera, *Pseudoleaia*, *Discoleaia*, and *Quadrileaia*, are thus synonyms of Novojilov's genera, *Japanoleaia*, *Cycloleaia*, and *Brachioleaia* respectively.

Now that interchange of publications is once again possible, it seems especially necessary to clarify, set limits to, and rectify errors in the overlapping and confused taxonomy of fossil conchostrachans.

PRINCIPLE 4

Given.—A broad range of shell outline is to be expected in populations of living and fossil conchostracans assignable to the same genus (Mattox, 1957, figs. 6–10).

Problem.—A common condition in the rock column is the finding of a single specimen or a few specimens assignable to one genus of conchostracans. If such material differs from existing genera only or mainly in shell outline, can such difference by itself be taken as a valid basis for erecting a new genus?

Discussion.—Only populations or a sufficient number of conchostracan valves to permit statistical treatment can reveal the range of variability of shell outline. The apparently unique outline of one or a handful of specimens cannot be taken as definitive of the variation to be expected if a larger portion of the population were studied. Accordingly, it is prudent, and in agreement with present-day knowledge of specific and generic variability, to avoid erecting new conchostracan genera in the absence of an adequate sample of the original population. This is especially so when the principal distinctness from previously established genera, is shell outline.

Conclusion.—Genera of the Leaiidae erected on the basis of one or very few specimens, where the primary distinction is shell outline, may be considered as invalid. When populations of equivalent shells are available, and when statistical treatment indicates no overlap with known genera, then, and only then, is it plausible and in accord with the evidence to erect a new genus. In lieu of such evidence, it corresponds much closer with the inherent limitations of the sparse material available, to assign it to the closest genus in terms of all characters other than shell outline. For example, if it has two ribs, and if such ribs are so distributed on the shell as to correspond reasonably close to the positional occurrence of the two ribs on specimens of the genus *Leaia*, the available specimens, however variable in configuration, should be assigned to the genus *Leaia*.

PRINCIPLE 5

Given.—Previously described specimens assigned to the genus *Leaia* and either inadequately described or figured by the original author is the "Given." Such material suggests to modern taxonomists of fossil conchostracans that it was originally incorrectly assigned and hence, in conjunction with fresh material being studied, is therefore lumped under a new genus name.

Problem.—What degree of reliability can be attributed to specimens such as noted under the "Given"? Is it more correct for a modern taxonomist to reinterpret from poor photographs or line drawings found in the literature, what the genotype or holotype must have looked like, or, to concede the inadmissibility of such unreliable evidence, and allow the matter to stand in abeyance?

Discussion.—A good example is Kobayashi's "new" genus *Bileaia*, a *nomen nudum* (Tasch, 1958). Further examples may be drawn from the published works of Nestor Novojilov (1952, 1954, 1956). For example, his genus *Gonioleaia* is based on a photograph of one incomplete valve (Novojilov, 1956a, pl. XIV, fig. 5; cf. Mitchell, 1925, pl. xliii, fig. 17; text-fig. 1, this paper).

Conclusion.—All workers on fossil conchostracans starting with Raymond (1946) then followed by Kobayashi (1954) and Novojilov (1952–56) have combed the literature and based on figured specimens, made reassignments on both the specific and generic levels. In one instance, Tasch (1956) did likewise, in erecting the genus *Monoleaia* to accommodate one-ribbed leaians. However, with the three first-named workers, reassignments from the literature became a kind of game. In many instances, first-rate absurdities have resulted as in Kobayashi's new genus *Eoleaia* based on Raymond's *Pseudoestheria leaiaformis* which Tasch found to have features that could have been caused by erosion rather than genetics (Tasch, 1956). Novojilov, as will be shown in detail further on in the present paper, has carried such reassignment practice to levels never even dreamed of by Raymond and Kobayashi. The argument given was that "a more profound study" of the Leaiidae had been made possible based on material collected by Russian geologists (Novojilov 1952). In 1952 this resulted in the erection of three subfamilies. In 1956 the three subfamilies expanded into ten! And for fossil conchostracans generally, new genera and higher categories are regularly forthcoming in a deluge of publications. (These will be evaluated in subsequent parts of the present critique).

In the opinion of the present writer, genera established on such fuzzy evidence are valueless. Accordingly, such genera will be rejected and detailed reasons given herein.

SYSTEMATIC EXAMINATION OF NOVOJILOV'S TEN SUBFAMILIES OF THE LEAIIDAE

1. Subfamily Leaiinae Novojilov 1952. This subfamily embraces nine genera, eight

of which were named by Novojilov, and only two of which are valid. The valid genera are: *Rostroleaia* Novijilov 1952 (Text-fig. 2), and *Japanoleaia* Novojilov 1952 (Text-fig. 3). The latter genus has priority over *Pseudoleaia* Kobayashi 1954 since it is based on the same genotype. It should be noted, however, that Novojilov's figure of *Japanoleaia rectangula* (1956a, fig. 57, p. 72) is an imaginative representation and does not correspond to Yokoyama's minute drawing (cf. Yokoyama, 1894; and Text-fig. 4, this paper). The degree of interpretation involved in Novojilov's taxonomy can be seen by comparing the evidence (Text-fig. 5) with the imaginative reconstruction (Text-fig. 6) of *Rostroleaia sarbalensis* Novojilov 1956. *Dolicholeaia* Novojilov 1952, based on Raymond's type *Pseudoestheria leaiaformis*, has priority over *Eoleaia* Kobayashi 1954, being based on the same type material as studied in the literature. However, as shown (Tasch, 1956) the distinctive characteristic of the type specimen can be attributed to erosion and not genetics. That makes *Dolicholeaia* invalid.

Leaianella Novojilov 1952, based on *Leaia leidyi* var. *salteriana* as figured in the literature, was originally reassigned to *Hemicycloleaia* by Raymond. However, as both Kobayashi (1954, p. 140–141) and Tasch (1956, Table 1) have indicated, there is no valid argument for separating this variety from the genus *Leaia*. Principles 4 and 5 are sufficient argument against such practice. *Leaianella* is therefore invalid. *Kaltanleaia*

TEXT-FIGS. *1–6, 7B, 8–19,* and *25A*—All figures are new drawings based on the original published line drawings or photographs. Source of each text-fig. is given after it. Hatched lines represent sediment or covered portions. Text-figs. 14 and 15A are photographic enlargements of Netschaev's figures.

1—Gonioleaia (=*Leaia*)*quadrata* (Mitchell, 1925) Novojilov, 1952, ×10. *1A* (Drawn from photograph *in* Mitchell, 1925, pl. xliii, fig. 17). Arrows indicate growth lines on shell that are visibly tangent to the lines above it, and thus indicate breakage or flattening of the shell at this point. *B*, Reconstruction based on text-fig. 1A. (Novojilov, 1952, pl. 2, fig. e), ×4. Note that covered portion of valve on right as well as tangent growth lines are not depicted.

2. Rostroleaia martynovae Novojilov, 1952, ×5. (*In* Novojilov, 1956a, pl. ix, fig. 4).

3. Japanoleaia rectangula (Yokoyama, 1894) Novojilov, 1952, ×7. (*In* Novojilov, 1956a, fig. 57, p. 72). Cf. text-fig. 4, the original. Note the extent of interpretation in text-fig. 3.

4. Estheria rectangula Yokoyama, 1894 (Pl. xxi, fig. 13) ×4.

5, 6. Rostroleaia sarbalensis Novojilov, 1956. *5*, photograph ×10 (Pl. ix, fig. 3). Note covered portions. *6*, Text-fig. 37, p. 51 (*in* Novojilov, 1956a) based on text-fig. 5, note reconstruction of covered portion.

7. Kaltanleaia (=*Leaia*) *rohdendorfi* Novojilov, 1952, ×10. B, cf. text-fig. 7A, this paper. (*In* Novojilov, 1956a, pl. 28, p. 41.)

8–11. Brachiorrhynchia Novojilov, 1956 (=*Leaia*). The following "new" (?) species appear to be variants of a single species: *8, B. chertensis; 9, B. trigonoides; 10, B. asiatica; 11, B. suspecta* (reduced from text-figs. 55,52,53,54, p. 67–68, Novojilov 1956a.)

12. Leaia baentshiana Geinitz, 1865 (fig. 3a). This figure was taken as the type of Novojilov's "new" genus *Tataroleaia* 1956 (=*Leaia*).

13. A, Leaia kargalensis Netschaev, 1894 (Fig. 35) ×3. *B, Symmetroleaia kargalensis* (Netschaev, 1894) (*In* Novojilov, 1952, pl. 2, fig. b) ×10. Cf. 13A and 13B with 16—all representing the same specimen.

14. Leaia kargalensis Netschaev, 1894 (Taf. X, fig. 36) ×2½; photograph of Netschaev's drawing. Note poor definition of surface features, ribs, etc. Cf. text-figs. 17 and 19—all representing the same specimen.

15. Leaia kargalensis Netschaev, 1894 (Taf. X, fig. 37) ×3. *A*, photograph of Netschaev's drawing. Note obscurity of umbo-rib relationship. *B*, Restoration of 15A (*in* Novojilov 1952, pl. 2, fig. d) ×3. Note how obscure features of original are interpreted. Cf. text-fig. 18, a more advanced interpretation of text-fig. 15A.

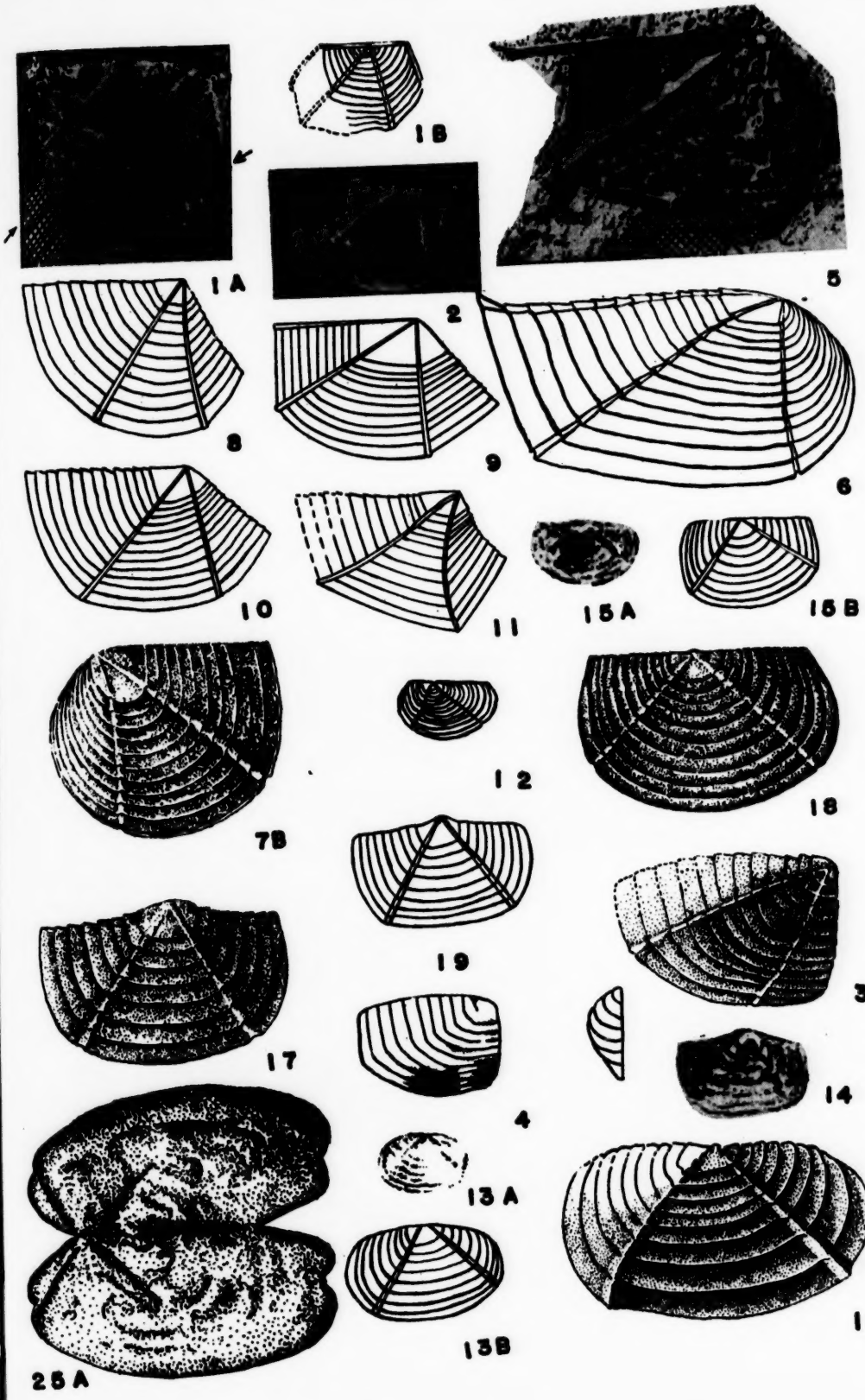
16. Symmetroleaia kargalensis Novojilov 1952 (*in* Novojilov 1956a, fig. 65, p. 81) ×8. Note poor definition of shell features.

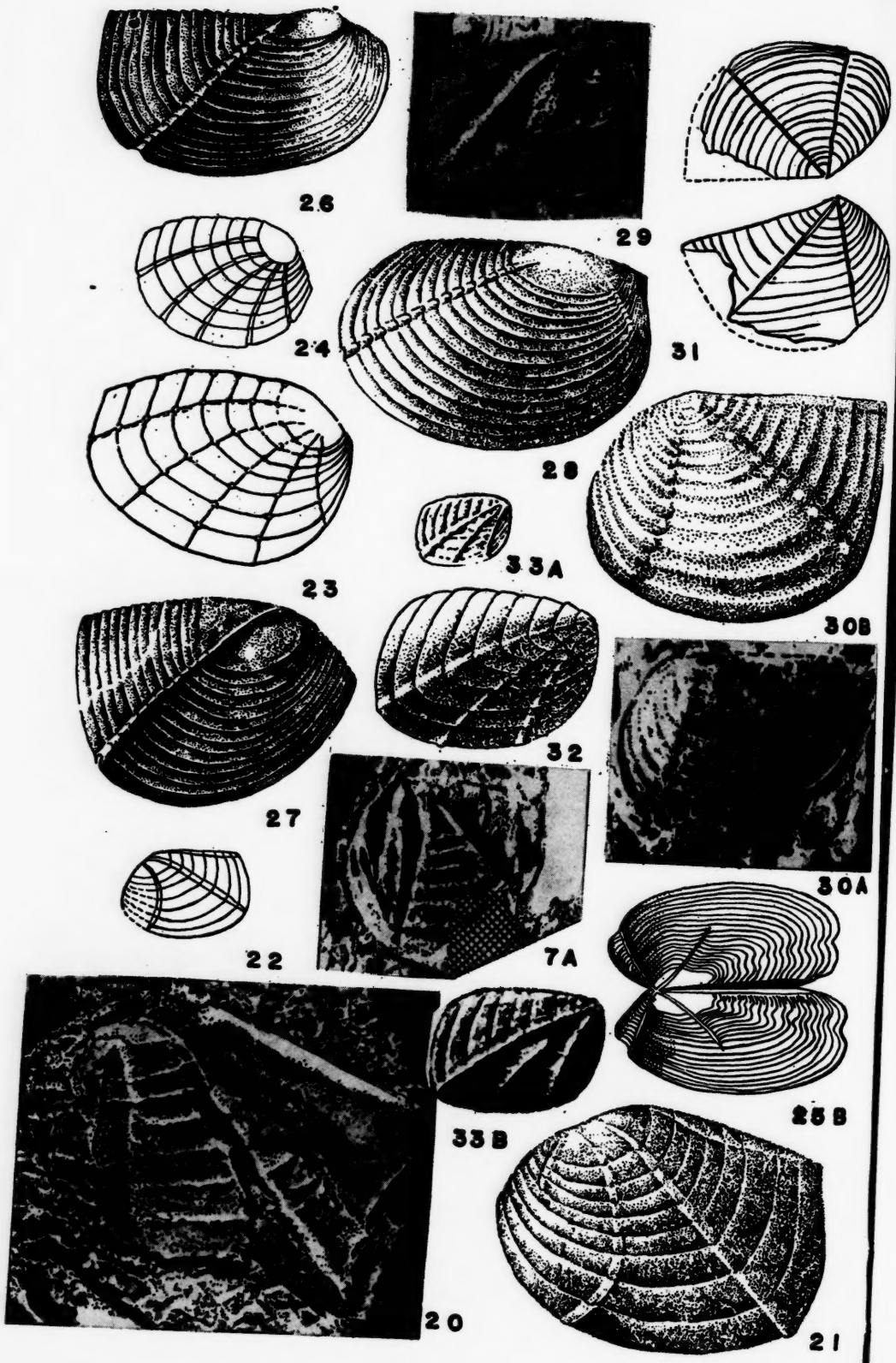
17. Kargalia uralica Novojilov 1956, ×6 (Fig. 66, p. 81). Cf. text-figs. 14 and 19.

18. Tataroleaia netshajevi Novojilov, 1952 (*in* Novojilov, 1956, fig. 67, p. 82) ×8. Cf. text-figs. 15A, the original, and 15B. Note how details have been added in this interpretation based on text-fig. 15A.

19. Symmetroleaia uralica Novojilov, 1952 (Pl. 2, fig. c) ×4. Cf. text-figs. 17 and the original fig. 14.

25. A, Amphikoilum ermakorum Novojilov, 1953 (*in* Novojilov, 1956a, pl. 1, fig. 4) ×14. Cf. text-fig. 25B for reconstruction of surface details on second plate of figures, this paper.


1A
1B
2
5
8
9
6
10
11
15A
15B
7B
12
18
19
3
17
4
14
13A
16
13B
25A


26
29
24
31
28
23
33A
30B
32
27
30A
22
7A
25B
33B
20
21

Novojilov 1952, defined as having a "pseudo-square shape" but undifferentiated from the typical genus *Leaia* otherwise based on Principle 4, is invalid and a synonym of *Leaia*. Incidentally, the type of this "new" genus *K.* (=*Leaia*) *rohdendorfi* Novojilov 1952 (Pl. 7, fig. 5, Novojilov 1956) is a single valve, broken or incomplete, along the postero-ventral sector. This figured specimen is ovate except for the almost straight dorsal margin (Text-fig. 7, this paper).

Mimoleaia Novojilov 1954, based on *Leaia tricarinata* Meek and Worthen 1868, was described as differing from *Leaianella* (=*Leaia*) by a less marked angulosity of the valves, and by having longer valves. Since valve shape is the primary discriminant, according to Principle 4, in the absence of populations and statistical demonstration of distinctness in this regard, we must place *Mimoleaia* as a synonym of *Leaia*. Raymond had originally reassigned this form to *Hemicycloleaia*, which as shown above, is a synonym of *Leaia*.

Brachiorrhynchia Novojilov 1956 was erected because it differed from *Leaianella* and other genera by the acute angle of the posterior part of the valve and by its relatively greater length. The type *B.* (=*Leaia*) *tanaidos* Novojilov 1956, as shown in a photograph (Pl. 12, fig. 1, in Novojilov 1956a) appears to be a typical specimen belonging to the genus *Leaia*. Applying Principle 4, it becomes clear that without a range of variation for a meaningful sample of this population, it must be deemed invalid to erect a new genus on the assumption of uniqueness of an obviously variable feature of the valve. This argument is even better sustained by the four other species of this genus that Novojilov figures by line drawings (Text-figs. 8–11, this paper), which appear to be variants of one species.

Australoleaia Novojilov 1954, was erected on the basis of the figured specimen *Leaia collinsi* Mitchell 1925 (Mitchell, 1925, pl. xliii, fig. 16). This genus is reported to "possess certain traits of resemblance with *Brachiorrhynchia* and *Leaianella* with which

---

TEXT-FIGS. *20–33, 7A* and *25B*—Text-fig. 33B is a photograph of the original drawing. All other figures are new drawings.

7. A, Kaltanleaia (=*Leaia*) *rohdendorfi* Novojilov, 1952. Based on photograph of the original (Pl. vii, fig. 5). Note missing portion, and valve configuration, ×10 (Novojilov, 1956a). Cf. text-fig. 7B and note extent of interpretation.

20–22. 20, Lioleaia permiana Novojilov, 1952, ×10 (drawn from photograph *in* Novojilov, 1956a, pl. xiii, fig. 4). Cf. text-figs. 21 and 22, based on the same specimen; *21,* Reconstruction of figure 20 (*ibid.*, fig. 58, p. 74) ×7; *22,* Line drawing reconstruction of text-fig. 20 (Novojilov, 1952, pl. 3, fig. a) ×4.

23–24. 23, Praeleaia triasiana Chernyshev, 1934 (Fig. 5, p. 124 ×8. Note that ribs begin midway up on umbo. Cf. text-fig. 24 based on it; *24, Lioleaiina* (=*Praeleaia*) *triasiana* (Chernyshev, 1934) Novojilov, 1952, ×8 (?). (*In* Novojilov, 1956a, fig. 74, p. 89). Note how ribs no longer begin on umbo, and nodes along ribs have been reinterpreted.

25. B, Amphikoilum ermakorum Novojilov, 1953. (Novojilov, 1956a, fig. 6b, p. 14) ×14. Cf. text-fig. 25A on first plate of figures, this paper.

26. Monoleiolophus unicostatus Raymond, 1946, ×7 (Novojilov, 1956a, fig. 7, p. 19). Raymond's type (M.C.Z. 4792) does not show the single radial starting high up on the umbo as depicted.

27. Jaxartus (=*Monoleaia*) *suchovi* Novojilov, 1954, ×10 (Novojilov, 1956a, fig. 9, p. 20).

28–29. Massagetes karagandensis Novojilov, 1954, ×13 (Novojilov, 1956a, fig. 8, p. 19). *28,* An interpretive text-fig. based on the photograph shown in text-fig. 29; *29,* Drawn from photograph of the type of Novojilov's new genus, ×10 (Novojilov, 1956a, pl. III, fig. 1). Text-fig. 28 cannot be derived from the published photograph.

30. Igorvarentsovia (=*Leaia*) *ingens* Novojilov, 1956. *A,* Drawing based on photograph of specimen no. 817/63 (Novojilov, 1956a, pl. 8, fig. 1) ×10; *B,* Text-fig. based on same specimen (Novojilov, 1956a, fig. 29a, p. 43; cf. Novojilov, 1956b, pl. 1, fig. 1) ×12.

31. Falsirostria (=*Leaia*) *bristolensis* (Ray.) Novojilov, 1954. Drawn and enlarged from Bolton's photograph (Bolton, 1911, pl. 27, figs. 5 and 6), ×5. Dashed lines indicate covered or missing portions of the valves.

32–33. 32, Teichium (=*Paraleaia*) *weissi* Novojilov, 1956, ×10 (Novojilov, 1956a, fig. 72, p. 87), an interpretive drawing of Kobayashi's fig. 30; *33A, Paraleaia? weissi* Fritsch (Kobayashi, 1954, fig. 30i, p. 142) an interpretive drawing of Fritsch's original; *33B, Leaia weissi* Fritsch, 1900, enlarged photograph of Fritsch's original drawing (Beyschlag and von Fritsch, 1900, Taf. 1, figs. 5a,b).

they occur at the same time." This is quite logical since the other two genera, as already shown, belong to *Leaia*, as does this "new" genus. The angular difference on the anterior sector of the valve is given as the chief difference between the "new" genus and the other two mentioned above, that is, in *Australoleaia* this angle is a "feeble right angle." Without a population analysis demonstrating that in dozens or hundreds of valves this is a persistent feature and not a mere point on a distribution curve with sharply, moderately, and feebly expressed angularity representing the true variability of this characteristic, it can hardly be accredited the uniqueness implied by erecting a new genus to set it apart.

If the argument is raised that seldom do we have such populations among fossil conchostracans, a simple answer may be given. All the more reason to proceed with great restraint before multiplying taxonomic names that cannot be adequately justified in light of modern knowledge of variability of all characters.

2. Subfamily Cycloleaiinae Novojilov 1952. This subfamily consists of six genera, five of which were named by Novojilov. *Cycloleaia* Novojilov 1952 has priority over *Discoleaia* Kobayashi 1954 since both were based on the same type described in the literature, namely, *Leaia discoidea* Mitchell (1925, pl. xli, fig. 6; pl. xliii, fig. 22). It is a valid genus. *Gonioleaia* Novojilov 1952, based on *Leaia quadrata* Mitchell (1925, pl. xliii, fig. 17) is described by Novojilov as having an angular shape, two carina and beak placed near the center. Actually, Mitchell himself set this apart as a new species of *Leaia*. He made this assignment on the basis of a single incomplete valve in which more than one-third of the posteroventral sector is missing and the beak characteristics are obscured by erosion (Text-fig. 1). Regardless of how apparently impressive the shape of the preserved portion of the valve is, it seems hardly adequate as material on which to erect a new genus. Study of Mitchell's photograph reveals that the last closely spaced group of growth lines form almost as a straight border. By contrast, all growth lines above this border have an ovate contour to which the border is tangent. It is impossible to resolve this anomaly by further study of the area on either side of this tangential contact between two sets of growth lines because on the right, the valve is covered by sediment, and on the left, it is eroded. Thus, one cannot determine whether the lower straight set of growth lines is a superimposed portion of another valve or whether the valve has been cracked and folded at this place. At any rate, Mitchell's photographic evidence, re-used by Novojilov, is incompetent to elucidate the actual shape of the figured valve. *Gonioleaia* is thus to be regarded as a synonym of *Leaia*.

Novojilov (1956) accepts *Bileaia* Kobayashi as valid and reproduces the latter's black and white drawing of the type (ibid., fig. 68, p. 84). The confusion arose because the original worker, Reed, failed to notice that two valves were superimposed. This genus is thus a *nomen nudum* (Tasch, 1958).

The genus *Tataroleaia* Novojilov 1956, has as its genotype, *Leaia baentschiana* Geinitz 1865 (Geinitz 1865, Taf. 2, figs. 2 and 3; Novojilov excluded fig. 2). Geinitz' original drawing is given in Text-fig. 12 of this paper. The position of the beaks in the anterior portion of the valve was the characteristic selected as distinctive, as well as the oval valves. However, Geinitz showed two figures of the same specimen (Figs. 3A and 3a). In Geinitz' Figure 3a, which is a minute drawing, the beak is shown as being much more anterior than in the larger Figure 3A, as well as a different shape. Furthermore, in a large sample of this population, one would expect a whole range in variability in these features. The establishment of a new genus, based on a lithographic drawing where shading, etc. are most misleading, is itself a procedure that can have little acceptance in modern times. Nevertheless, even in these terms, *Tataroleaia* is unacceptable since it was set up on features which are not unique but extremely variable and cannot be discriminated from large samples of the genus *Leaia*, of which it is a synonym. A further point may be made regarding Geinitz' Figure 3A. In the anterodorsal sector the valve is distorted, broken, cracked, or eroded, thus leaving in doubt the real configuration of the valve.

Novojilov erected a new genus *Symmetroleaia* (1952, fig. 2) based on Netchaev's type

(1894, p. 379–380, Taf. 5, figs. 35,36, and 37) *Leaia kargalensis* (ibid., fig. 35). From the three minute lithographic figures of this species given in Netchaev's paper, Novojilov was able to differentiate three distinct species! It is important to contrast Netchaev's figures and the ten-time enlargement given in Novojilov's interpretation of these figures (cf. Text-figs. 13–15 and Text-figs. 16–18, this paper). When the minute lithographic representations are magnified times seven, no clear view of shell features can be seen. Yet, Novojilov (1952, fig. 2) shows a clearcut determination of all essential details with no other evidence to go on than Netchaev's original drawings. The specimen Novojilov selected as his type for *Symmetroleaia*, as far as can be determined from the published evidence, differs from *Cycloleaia* only in being less rounded and more ovate. The actual configuration cannot be indisputably determined from Netschaev's Figure 35. This is emphasized by the fact that Novojilov himself gave two different versions of Netschaev's figure (Novojilov, 1952, fig. 2b, and 1956, fig. 65, p. 81). In light of this and considering Principle 4, erection of a new genus is unwarranted. Accordingly, *L. kargalensis* Netschaev is assigned here to *Cycloleaia* Novojilov making *Symmetroleaia* a synonym of that genus.

Another of Netschaev's figures (1894, pl. X, fig. 36) also assigned by him to *L. kargalensis*, was selected as the type of a new genus by Novojilov. The name of this genus is *Kargalia* Novojilov 1956. Netschaev's figure 36 (Text-fig. 14, this paper) when enlarged five times (Novojilov, 1952, fig. 2c; Text-fig. 19, this paper) and fourteen times (Novojilov, 1956, fig. 66, p. 81; Text-fig. 17, this paper) also changed its configuration and details somewhat. This, once again shows the absurdity of trying to represent clearly Netschaev's minute and unclear figures. Whereas Netschaev's Figure 36 shows what appears to be a remnant of a single carina, Novojilov's interpretation (1956, fig. 66) shows two complete carina, and other surface details not derivable from the published figure. It follows that the genus based on such type material is unacceptable.

An additional observation is of interest here. Novojilov originally (1952) assigned Netschaev's Figure 36 to a new species and a new genus, *Symmetroleaia uralica*. In 1956 *S. uralica* was again reassigned, this time as the genotype of a new genus *Kargalia*. This, in itself, makes apparent the uncertainty over its correct assignment. The fact that no new evidence was adduced by Novojilov between 1952 and 1956, as pertains to this species, and that his sole reliance in 1956 continued to be Netschaev's sorry Figure 36, emphasizes this point.

Since *Symmetroleaia*, as shown above, is a synonym of *Cycloleaia*, it follows that *S. uralica* (=*Kargalia uralica*) is also a synonym of this genus.

3. Subfamily Lioleaiinae Novojilov 1952. This subfamily embraces three genera, two of which are synonyms of existing genera. The remaining genus *Brachioleaia* Novojilov 1952, has priority over *Quadrileaia* Kobayashi 1954 since both are based on *Leaia quadriradiata* Mitchell as figured in the literature (Mitchell, 1925, pl. xli, fig. 7). It is a valid genus. *Lioleaia* Novojilov 1952 was based on one incomplete specimen of *Lioleaia permiana* Novojilov 1952. The genotype (Novojilov 1956, pl. xiii, fig. 4 and text-fig. 58; cf. Novojilov, 1952, fig. 3a; all these figures are of the same specimen, 681/100) is incomplete in the anteroventral sector and the posterodorsal section is covered by sediment (original photograph, Novojilov 1956, pl. xiii, fig. 4, and line drawing prepared from it; cf. Novojilov's fig. 58 and the 1952 drawing; Text-figs. 20–22 of this paper). Aside from one specimen, and aside from its incomplete preservation, once again valve shape requires that Principle 4 be invoked, since the distinctive characteristic is reported to be "elongate valves that transform with age." Thus, *Lioleaia* is a synonym for *Leaia*.

Lioleaiina Novojilov 1952 based on *Praeleaia triasiana* Chernyshev 1934 is described as having five carinate radials that begin in the vicinity of the lower margin of the initial valve (Novojilov, 1952). However, in his 1956 paper, Novojilov depicts this specimen as having radials that do not begin on the umbo (Text-fig. 74). (Cf. Text-figs. 23,24, this paper which show Chernyshev's original figure and Novojilov's fig. 74). This point is important be-

cause as shown by Tasch (1956), leaiid-type valves have radials that start on and/or cross the umbo, in whole or part, as contrasted with estheriid-type valves. Novojilov notes (1956, p. 89) that Chernyshev's species was "incorrectly" assigned to the genus *Praeleaia*. No explanation of why this is so was given. Novojilov's line drawing of Lutkevich's figures (Numbers 17 through 19a on pl. XXXVI *in* Lutkevich, 1929) show a dorsal carina or rib (Novojilov, 1956, fig. 69), which Lutkevich's photographs do not show and which he clearly states is not present. "Thus, on the carapace there are 4 or 5 diagonal ridges, whilst on the dorsal margin, the keel is absent" (Lutkevich, 1929, p. 139). Having clarified the nature of the radials on Chernyshev's specimen mentioned above and of Lutkevich's genotype *Praeleaia quadricarinata*, there is no good reason in published evidence for (a) a new genus to be erected (b) or an explanation as to why *P. triasiana* does not belong in *Praeleaia*. This last named genus was used as a basis for still another subfamily to be discussed later. We may conclude, then, that *Lioleaiina* Novojilov 1952 is a synonym of *Praeleaia* Lutkevich 1929 and that the latter is a valid genus.

4. Subfamily Amphikoilinae Novojilov 1953. This subfamily was erected to embrace a single new genus, *Amphikoilum* Novojilov 1953 (Text-figs. 25a and 25b, this paper). This is a very interesting and apparently valid new genus. It is represented by more than one hundred specimens. With a sample of this size, a population analysis is possible and should have been provided. It is hoped that this information will be forthcoming.

5. Subfamily Monoleiolophinae Novojilov 1956. This subfamily was erected to embrace four genera only one of which is valid as given, and three of which are synonyms for extant genera. The genus from which this subfamily takes its name, *Monoleiopholus* Raymond 1946, is figured by Novojilov (1956, text-fig 7., and Text-fig. 26, this paper). His figure, after Raymond's photograph (ibid., pl. 3, fig. 11) shows the single radial as beginning midway up the umbonal portion, i.e., crossing it. My study of the holotype (M.C.Z.4792) as well as Raymond's description (ibid., p. 262) makes it clear that "the low-rounded crested ridge" . . . "dies out at both ends reaching neither the beak nor the margin." On this basis, Tasch (1956) placed *Monoleiopholus* with the estheriellids.

Tasch (manuscript submitted February 22, 1955 and published September, 1956, Journal of Paleontology) erected a new genus *Monoleaia* to embrace one-ribbed leaiids, that is, valves bearing a radial that crossed the umbo wholly or partially. In 1956, using the same type, *Leaia unicostata*, Novojilov (1956, month not given, p. 21 and fig. 10) erected a "new" genus, *Inkus*. This genus is a synonym of *Monoleaia* (see: Tasch, 1956, figs. 10,10a and cf. Novojilov, 1956, text-fig. 10). Another genus, *Jaxartus* Novojilov 1954, was conceived as being close to *Monoleiopholus* which the present author has shown is an estheriellid (Novojilov, 1956, p. 20 and fig. 9; also pl. III, fig. 2; Text-fig. 27, this paper). It was based on a single incomplete specimen (Novojilov, 1956, pl. III, fig. 2) with the posterior-dorsal sector missing. *Jaxartus* Novojilov 1954 is here taken out of its association with *Monoleiopholus* and placed in synonomy along with *Inkus*, under *Monoleaia* which has priority over *Jaxartus* since it is based on Reed's specimen dated 1929.

The remaining genus in this subfamily, *Massagetes* Novojilov 1954, appears to be a valid genus. I say "appears" since Novojilov's drawing of the genotype *M. karagandensis* (Text-fig. 8, based on specimen 908/16 *in* Novojilov, 1956, p. 19) is not derivable from the photograph of this identical specimen shown on plate 3, fig. 1 (ibid.). (Both illustrations are shown in Text-figs. 28 and 29, this paper). The presence of two carina, the typical single carina of *Monoleaia* species and an apparent anterior embryonic carina, are both present. It is this last feature that appears to be its unique character. Based on the available published evidence, *Massagetes* Novojilov 1954 is regarded here as a valid new genus. It is, of course, desirable that rubber casts of such questionable specimens be distributed to specialists for independent verification.

6. Subfamily Hemicycloleaiinae Novojilov 1956. Under discussion of the genus *Leaianella* (see above), it was shown why

Raymond's genus *Hemicyloleaia* was reassigned to the genus *Leaia*. This is the genus on which the subfamily is based. Two other genera originally placed under subfamily Leaiinae Novojilov 1952, were shifted to this subfamily in 1956. These genera, already discussed (see Subfamily 1 above) are: *Dolicholeaia* and *Kaltanleaia*. The remaining genus to consider under this subfamily is *Siberoleaia* Novojilov 1954. The genotype is *Hemicycloleaia haynesi* Raymond 1946 (Raymond, 1946, pl. 6, fig. 6) and Novojilov's line drawing (Novojilov, 1956, fig. 16 and cf. photographs pl. III, fig. 5, and pl. xiii, fig. 6) based on a specimen collected in the Stephanian Tentek Series, do not correspond. For example, the latter has a posterior carina or rib that does not reach the valve margin, while in Raymond's specimens, both ribs do. At any rate, the genus *Siberoleaia*, based on Raymond's type, is a synonym of *Leaia*.

7. Subfamily Igorvarentsoviinae Novojilov 1956. Two genera are embraced by this subfamily. An established genus, *Acantholeaia* Almeida 1950, is a valid genus. In addition, there is a "new" genus included, *Igorvarentsovia* Novojilov 1956. Novojilov's procedure appears to be as follows: a valve or a few valves are found in some part of the extant or recent collections of Russian museum or field collections. If they differ in any character such as shape, etc., a new genus is erected and a search of the literature made. The numerous specimens found described in the literature are then reassigned to the "new" genus. For example, *Leaia herriana* Guthörl 1934 (Novojilov 1956a, fig. 30) was reassigned to this genus. Now, the distinguishing feature, according to Novojilov, is the existence on these valves of "bare" or exposed carina. That is, the carina are like the usual ribs but are preserved as points or bead-like dots (Text-fig. 30, this paper). This is more likely a result of weathering and mode of preservation than something distinctive genetically (Novojilov, 1956a, pl. viii, figs. 1 and 2). All previous workers finding equivalent valves bearing similar features realized this. Guthörl and Pruvost assigned them to the genus *Leaia* while Raymond assigned one such species to his *Hemicycloleaia*, which as shown above, is a synonym of *Leaia*. No previous worker erected a new genus on this type of evidence. There is thus good reason to place *Igorvarentsovia* under the synonymy of *Leaia*. Incidentally, this genus was erected on the basis of two valves, one of which is an incomplete right valve.

Novojilov was impressed by a certain resemblance of the new form (*Igorvarentsovia*) and *Acantholeaia*. He concluded that "the spines of the carina of *Acantholeaia* represent a later phase phylogenetically, of the development of outgrowths in the form of beads" as found in *Igorvarentsovia* (Novojilov, 1956c). However, the spined carina of *Acantholeaia* are expressed on the dorsal and anterior margins of the valve while *Igorvarentsovia ingens*, the genotype of the "new" species, bears no carina on these margins (cf. Novojilov, 1956a, figs. 29 and 32). There is thus no objective way of reaching the same conclusion Novojilov did regarding the "kinship" of the two named genera.

8. Subfamily Rostroleaiinae Novojilov 1956. Three genera are included under this subfamily. The genus *Rostroleaia* Novojilov 1952 is apparently valid and characterized by being limnadiform. This character is expressed by a recurvature of the dorsal margin that may end in a pointed projection. Originally assigned to the subfamily Leaiinae in 1952, it was transferred to its own subfamily in 1956. However, another species assigned to this genus, *R. sarbalensis* Novojilov 1956, and not the genotype, is based on a specimen (no. 611/300) of which the photograph (ibid., pl. IX, fig. 3) and the text-figure made from it (ibid., fig. 37, p. 51 and Text-figs. 5 and 6, this paper) do not correspond. The photograph shows the area on the valve above the most posterior of the two carinae covered by sediment, and the dorsal margin, effectively straight, except for the posterior end which is slightly upcurved. It is not clear if this last feature is genetically caused or due to fracture and displacement. The text-figure reproduces this photograph in lines which do not show that a whole section is covered by sediment. It shows a marked upcurvature of the end of the dorsal carina which cannot be derived from the photograph of the actual material studied. Rather, it must be viewed as an imaginative interpretation.

The other two genera included under this

subfamily are *Falsirostria* Novojilov 1954 and *Granirostria* Novojilov 1954. The genotype of *Falsirostria* is *Leaia bristolensis* (Ray.) 1946 (Novojilov, 1956a, pl. ix, fig. 1). Novojilov reproduces Bolton's photograph (Bolton, 1911, pl. 27, figs. 5 and 6) of a right and left valve (Text-fig. 31, this paper, for the actual material available). The ventral-posterior portion of the right valve is missing and the sediment covering this sector extends along the ventral margin almost to the first or anterior carina. The figure of the left valve, as photographed by Bolton, ends abruptly so that a portion of the dorsal continuation and the posterior margin are not seen. Raymond (1946, p. 284–285) concluded from these photographs "this is a real *Leaia*." Based on Principles 4 and 5 as stated earlier, *Falsirostria* can be placed under the synonomy of *Leaia*. However, it can be shown to be invalid on the *prima facie* evidence. For example, other species assigned by Novojilov to this "new" genus show a false rostral effect or an elongation to a blunt termination of the dorsal and the posterior margins (Novojilov, 1956a, figs. 33–35). However, the type material is incomplete in these very sectors of the valve (Text-fig. 31, this paper), and thus in no objective sense can permit such extrapolation. *Granirostria* Novojilov 1954 was erected on the basis of its possessing a very acute postero-dorsal angle like *Falsirostria* but differed from it in lacking a rostral apophysis, and possessing a thickened dorsal margin and smaller height of the valve. The first two items have been treated in our discussion of *Falsirostria*. The last two characters might have specific, but certainly not generic, value. Even these last two characters cannot have significance when they describe one specimen instead of dozens or hundreds of valves. Such samples might show a whole range of "thickening" of the dorsal margin and that demonstration itself would suffice to eliminate the character as a discriminatory one between different samples where overlap in ranges would be expected.

9. Subfamily Praeleaiinae Novojilov 1956. Three genera are embraced by this subfamily: *Praeleaia* Lutkevich 1929, *Paraleaia* Raymond 1946—both valid genera; in addition, *Teiichium* Novojilov 1956 was erected on the genotype *Leaia weissi* Fritsch 1900 (Beyschlag and von Fritsch, 1900, Taf. 1, figs. 5a,b). In 1954, Kobayashi (p. 141–142 and fig. 30-i) reassigned this species to *Paraleaia*. Once again, we have an example of assignment and reassignment based on a lithographic drawing of a single valve. In such cases it is desirable to suspend judgment since the published figure, with its different values of shading that readily distort features of the test of taxonomic interest, is at best a kind of circumstantial evidence. It is certainly not equal to an actual examination of the original type material. However, since Kobayashi assigned this specimen to *Paraleaia*, the question may be raised as to whether this is an acceptable assignment. The clue, as far as the present writer is concerned, is the median accessory radial which can be seen on the original figure. Novojilov (1956, p. 87; fig. 72) who derived his figure from Kobayashi's drawing—itself an interpretive drawing compared to Fritsch's original—makes no mention of this accessory radial and shows a figure that does not correspond to the original (for the three figures of *Leaia weissi*, Text-figs. 32,33A, and 33B, this paper). It is this feature, noted by Kobayashi, that makes assignment of it to *Paraleaia* plausible. That is so since paraleaiids are characterized by a median groove or fold. The accessory radial merely extends this definition logically. Accordingly, *Teiichium* Novojilov 1956 is a synonym of *Paraleaia* Raymond 1946.

10. Subfamily Estheriellinae Kobayashi 1953. Novojilov (1956a, p. 88) demoted Kobayashi's family of the same name to subfamily status. He went further and placed this subfamily under the Leaiidae. Tasch (1956, p. 1254–1255) pointed out the important advance made in the taxonomy of fossil conchostracans by Kobayashi when he raised the *Estheriella*-type carapace from generic to familial status—i.e., forms having radial ridges that do not cross the umbo. It was also demonstrated that a clearcut distinction could be made between leaiid- and estheriellid-type conchostracans on this basis, since "kinds, relationship, and number" of ridges most nearly approached the "total morphological pattern." Principle 3 formulated this condition (ibid., p. 1256). By Novojilov's approach, one of the really distinct set of characters discriminating be-

tween two conchostracan families is obscured and lost. It is therefore rejected and Estheriellidae Kobayashi 1953 (not 1952 as stated in Novojilov, 1956a, p. 88) restored.

We have still to consider the genera grouped under this subfamily as treated by Novojilov. The genera included are: *Mesoleaia* Kobayashi 1954, *Pseudoestheriella* Novojilov 1956, *Estheriella* Weiss 1875, *Tancrediella* Novojilov 1956, *Nyasestheriella* Kobayashi 1954, *Lioleaiina* Novojilov 1952, *Palermisca* Novojilov 1956. Of these, *Mesoleaia* Kobayashi was shown to be a synonym of *Estheriella* Weiss (Tasch, ms. 1955; 1956, p. 1255). The latter genus is certainly valid but belongs under the distinct family Estheriellidae as discussed above. *Nyasestheriella* Kobayashi is also a valid genus and belongs under the Estheriellidae (Tasch, ibid., table 1). That leaves the four genera established by Novojilov. *Pseudoestheriella* was based on *Estheriella nodocostata* (Jones, 1891; p. 54, pl. 2, figs. 11 and 13) and was said to differ from *Mesoleaia* by the large number of ribs forming on the different stages of growth (Novojilov 1956a, p. 102). However, since these "ribs" do not begin on or cross the umbo, Jones' species is a typical estheriellid and correctly assigned by Jones to that genus. *Pseudoestheriella* is thus a synonym of *Estheriella*. *Tancrediella* Novojilov 1956 was based on *Estheriella weissi* Picard 1909 as its type (Picard, 1909, p. 621 and Taf. 3, fig. 6). The line drawing in Novojilov (1956a, fig. 78, p. 94) shows much more detail than can be found in Picard's original figure. For example, the line drawing in Novojilov shows thirteen radial ribs whereas Picard points out that only twelve are present. Furthermore, viewing his small figure under magnification, only twelve can be counted. Again, all radial ribs appear to start at or near the end of the umbo in the line drawing whereas in Picard's figure, several middle ones started in the median sector. The general configuration is accurately shown in the line drawing. The discrepancies are noted to highlight how precarious it is to establish new genera based on one inadequately figured specimen found in the literature.

However, regardless of the elongate nature of the valves, no radials cross or begin on the umbo and hence, by Principle 3 (Tasch, 1956 and discussion above), the specimens referred to are estheriellids. Then, by Principle 4, the variant valve shape can derive taxonomic status only if based on samples large enough to permit statistical treatment. Accordingly, *Tancrediella* becomes a synonym of *Estheriella*.

Lioleaiina Novojilov 1952 was originally assigned to subfamily Cycloleaiinae in 1952. It was shifted to subfamily Estheriellinae in 1956. It has already been thoroughly discussed under the former subfamily (see subfamily 3 above).

The single genus in this subfamily that remains to be considered is *Palermisca* Novojilov 1956. It was based on the type *Estheriella radiata* Salinas 1897. E. Kittl (1912, p. 10) wrote:

> Die aus Raibler (?) Mergeln der sizilianischen Trias von Salinas beschrieben Formen welche unten namentlich angeführt sind, mögen zum Teil Halobienbrut darstellen.

In other words, in this monograph on several pelecypod families including the Halobiidae, Kittl observed that some of Salinas' (1897) estheriids were not conchostracans at all but rather were embryonic or young stages of the marine pelecypod *Halobia* (cf. Newton, 1925, p. 81). In reaching this conclusion, Kittl explained his reasoning: "Namentlich die mehr rundlichen Formen würde ich lieber nicht zu *Estheria* stellen." (Ibid.)

Jones (1905), finding certain details of structure not expressed in Salinas' species *Estheria radiata*, added the varietal name, *multilineata*, and reassigned Salinas' species to *Estheriella* (Newton, *op. cit.*, p. 81). Since he found new Malayan specimens in abundance, Newton was able to show that *E. radiata* (Salinas) var. *multilineata* T. R. Jones was a synonym of the pelecypod *Halobia* cf. *moussoni* Merian em. Stoppani (Newton, *op. cit.*, pl. III, figs. 3–10). In light of this and Kittl's earlier conclusion, it is plain that Salinas' species, selected as the genotype for *Palermisca* Nov. 1956, is a pelecypod. *Palermisca* Novojilov 1956 is, therefore, a *nomen nudum*.

RECAPITULATION AND SUMMARY

In the absence of clearcut principles for classifying fossil conchostracans, an enormous complexity of the taxonomy can arise as evidenced by the presentation given

above. The ten subfamilies are largely based on genera that are found to be synonyms of existing genera. Plainly, that indicates that these subfamilies should be rejected.

The prevailing practice in conchostracan taxonomy, of reassigning known species and genera to "new" species and genera on an arbitrary basis, is certainly confusing and not to be condoned—all the more so in the absence of full discussion of what principles are being followed and what justification there is for such shifts.

One incomplete valve or two fuzzily figured valves should be considered inadequate evidence on which to erect new genera and subfamilies. As for higher categories, such as families of fossil conchostracans, there are no right or wrong assignments, only more or less effective or usable ones in the present state of knowledge of the subject (cf. Tasch, 1956).

ACKNOWLEDGMENTS

The present report was made possible by a Sigma Xi grant-in-aid for preparation of a supplement to the Conchostracan unit of the Branchiopoda chapter of the TREATISE. Illustrations were financed in part by this grant and by a University of Wichita Research Fund Award.

All of Novojilov's papers to date were translated into French by the Paris Centre d'Etudes et de Documentation paléontologiques, under J. Roger's supervision at my request. Translations from the French were made by the writer. The Sigma Xi funds financed the translations from the Russian to the French.

REFERENCES

BEYSCHLAG, F., & VON FRITSCH, K., 1900, Das Jüngere Steinkohlengebirge und das Rothliegende in der Prov. Sachsen und den angrenzenden Gebieten: Berlin, Abh. K. Preuss. Landesanst. N.F. Hft. 10, 263 p., Taf. 1. (*Leaia weissi* Fritsch).

BOLTON, H., 1911, Faunal horizons in the Bristol coalfield: Quart. Journ. Geol. Soc. London, v. 67, p. 316–340, pl. xxvii.

CHERNYSHEV, B. I., 1934, On some Branchiopoda from Kuznetsk Basin: Soc. des Nat. Leningrad, Travaux Geol., v. 63, p. 122–125.

DE ALMEIDA, F. F. M., 1950, *Acantholeaia* un novo Género de Leaiadae: Brazil, Min. da Agric. Div. de Geol. e Min. Notas Prelim. e Estudies, no. 51, p. 1–6, pl. 1.

GEINITZ, H. R., 1865, Über einige seltene Versteinerungen aus der unteren Dyas und der Steinkohlen-Formation: Neues Jahrbuch Min. Geol. Paleont. Stuttgart, p. 385–389, taf. 2–3.

JONES, T. R., 1891, On some more fossil Estheriae: Geol. Mag. n.s., v. 8, no. 11, p. 49–57, pl. 2.

KITTL, E., 1912, Materialien zu einer Monographie der Halobiidae und Monotidae der Trias.: Wien, Erforschung D. Balatonsees, Bd. 1, Teil 1, Anh. Paleontologie 2, Pt. IV, p. 1–230, 10 pls.

KOBAYASHI, T., 1954, Fossil estherians and allied fossils: Univ. Tokyo, Jour. Fac. Sci., v. 9, sec. 2, pt. 1, p. 1–192.

MATTOX, N. T., 1957, A new estheriid conchostracan with a review of other North American forms: Amer. Midland Nat., v. 58 (2), p. 367–377.

MITCHELL, JOHN, 1925, Descriptions of new species of *Leaia:* Linn. Soc. New South Wales, v. 1, pt. 5, p. 438–447, pls. 51–53.

NETSCHAEV, A. V., 1894, Faune du Permien de la zone orientale de la Russié Europe: Kazan Univ. Obsh. iestestv. Trudy, t. 27, no. 4, p. 379–380, taf. 5.

NEWTON, R. E., 1925, Marine Triassic fossils from the Malayan Provinces of Kedah and Perak: Geol. Mag., v. 62, p. 76–84, pl. III.

NOVOJILOV, N. I., 1952, New generic groups in the phyllopod crustaceans of the family Leaiidae: Dokl. Akad. Naouk. SSSR, t. 85, no. 6, p. 1369–1372.

——, 1954, Phyllopodes bivalves—Leaiidae provenant des depôts carbonifères du Kazakhstan: Dokl. Akad. Naouk. SSSR, t. 96, no. 6, p. 1241–1244 (Trans. by S. Ketchian.)

——, 1956a, Crustacés phyllopodes bivalves. 1. Leaiidaes: Akad. Nauk. SSSR, Trav. Inst. Paléontol., t. 61, 128 p., 14 pls.

——, 1956b, New genera of the Leaiidae, Crustacea, Phyllopoda, *Igorvarentsovia*, of the Carboniferous: Dokl. Akad. SSSR, Paléontologie, T. 106, no. 6, p. 1087–1090, pl. 1.

PICARD, E., 1909, Über den Unteren Buntsandstein der Mansfolder Mulde und Fossilen: Jahrb. d. Preuss. Geol. Landesanst., v. 30, p. 618–622.

RAYMOND, P. E., 1946, The genera of fossil Conchostraca—an order of bivalved Crustacea: Bull. Mus. Comp. Zool. Harvard, v. 96, no. 3, p. 1–307, 6 pls.

SALINAS, E., 1897, Sulle *Estheria* del Trias di Sicilia: Mus. Geol. Min. R. Univ., Palermo, 1897, p. 1–12, pl. 1.

TASCH, P., 1956, Three general principles for a system of classification of fossil conchostracans: Jour. Paleontology, v. 30, p. 1248–1257.

——, 1958, Note on *Bileaia* Kobayashi 1954, *nomen nudem:* Jour. Paleontology, v. 32, p. 637–638.

YOKOYAMA, M., 1894, Mesozoic plants from Kozuke, Kii, Awa, and Tosa: Jour. Coll. Sci., Imp. Univ., Japan, v. 7, art. 3, p. 230–31, pl. xxi.

JOURNAL OF PALEONTOLOGY, V. 32, NO. 6, P. 1107–1148, PLS. 143–148, 27 TEXT-FIGS., NOVEMBER 1958

THE GENERA, SPECIES AND SUBSPECIES OF THE FAMILY EURYPTERIDAE, BURMEISTER, 1845

ERIK N. KJELLESVIG-WAERING
Pan Venezuelan Oil Company, Caracas, Venezuela

ABSTRACT—A synopsis, review and reclassification of all eurypterids referred to the family Eurypteridae, Burmeister, 1845. Four genera, *Eurypterus*, *Onychopterella*, *Erieopterus* n. gen., and *Tylopterella* are recognized, and all species are reclassified. One new species and three new subspecies are described; and additional specimens and morphological details hitherto unknown are discussed. A complete check-list and bibliography of the family are included.

THE first record of discovery of an eurypterid was made in 1818 by Dr. S. L. Mitchill who figured and described, but did not name, the remains from the Silurian (Fiddlers Green) of Oneida County, New York which he mistook for a catfish of the genus *Silurus*. The prosomal appendages, or walking legs, were mistaken for the barbels of a catfish. DeKay (1825, p. 375) correctly recognized the arthropod nature of the fossil, and erected the genus *Eurypterus*, with the species *E. remipes*, which he considered to be a branchiopod. This constituted the first recognition and description of an eurypterid in the literature. Harlan (1834, p. 98) followed, by describing another species, *Eurypterus lacustris* from the Silurian (Williamsville) of western New York.

The genus *Eurypterus* became established and many eurypterids, except the great pterygotids, have been at one time or another referred to this genus. As a consequence, the genus became over-burdened with species not even remotely related to the genotype and its range was increased gradually until it encompassed the total range of all Eurypterida from the Ordovician to the Middle of the Permian. Actually the genus *Eurypterus*, or indeed the Family Eurypteridae, does not occur above the lower Devonian and is a genus of a highly specialized nature which is common only in the upper Silurian where it developed, explosively, into enormous numbers and reached its greatest diversification. Above and below the upper Silurian, the genus, and for that matter, the family, are rarely encountered.

The family Eurypteridae, as here defined, is found in all types of sediments although a marked preference is evident for calcareous muds with a high magnesium content (waterlimes). The habitat of the eurypterids has occasioned considerable debate in the past and will not be repeated here. It is of importance to note that individual genera and species of the Eurypterida lived in separate environments as far as the record reveals. Too much stress has been placed on the environment of *all* the Eurypterida as a group without regard to preferences of genera, species and even, possibly, subspecies. For example, species of the newly described genus *Erieopterus* reveal that in the lower Devonian, *E. latus* (Ruedemann) of Wyoming probably was a fresh water or brackish water animal, whereas *E. brewsteri* (Woodward) of Scotland was a fresh water form. On the other hand, the Silurian *E. microphthalmus microphthalmus* has repeatedly been found intimately associated (see plate 147, fig. 3) with definite marine brachiopods such as *Crispella vanuxemi* (Hall). The test of this form is thickened, perhaps in order to withstand marine conditions. There is no good reason why forms such as this species could not have lived in the sediments where they are found. In general, however, the following represents the writer's conception of the habitat of the eurypterids, in which it should be noted that a general and gradual change from marine to fresh water conditions is indicated (essentially this is the opinion advanced by Clarke and Ruedemann in 1912):

Ordovician: All in marine strata.
Silurian: Some genera in marine beds; others indicating brackish water, and at least one genus is found in deposits suggesting hypersaline conditions.

Devonian: Nearly all found in brackish or fresh water deposits. A very small percentage is found associated with typical marine beds.
Mississippian: All in fresh water deposits except one fragment that occurs with marine fossils.
Pennsylvanian: All in fresh water deposits, generally intimately associated with coal beds.
Permian: All in fresh water deposits.

The river hypothesis of O'Connell (1916) is not supported by the fossil record.

The genera of the Eurypteridae as defined here are based mainly on the structure of the prosomal appendages and the ornamentation of the exoskeleton. As thus defined, four genera are recognized, namely, *Eurypterus*, DeKay, 1825, *Onychopterella*, Størmer, 1951, *Erieopterus*, new genus, and *Tylopterella*, Størmer, 1951. Differences and descriptions of these genera are discussed in the text of this report. Seventeen named and unnamed species and subspecies are recognized for the genus *Eurypterus*, eleven species and subspecies are included in the genus *Erieopterus*, two species for the genus *Onychopterella* and one species for the genus *Tylopterella*. The species and subspecies of the family Eurypteridae, as thus divided, are as follows, given in more or less stratigraphical order for each genus:

Genus *Eurypterus:*	
E. (?) *pristinus* Clarke & Ruedemann	Ordovician: Schenectady New York
E. (?) *decipiens* Ruedemann	Ordovician: Schenectady New York
E. cyclophthalmus Laurie	Silurian: Gala-Tarannon Scotland
E. minor Laurie	Silurian: Gala-Tarannon Scotland
E. pittsfordensis Sarle	Silurian: Pittsford New York
E. remipes tetragonophthalmus Fischer	Silurian: Ludlow Podolia, Oesel, etc.
E. remipes swartzi n. ssp.	Silurian: Wills Creek West Virginia
E. remipes remipes DeKay	Silurian: Fiddlers Green New York
E. remipes lacustris Harlan	Silurian: Williamsville New York, Ontario
E. dekayi Hall	Silurian: Williamsville New York
E. remipes laculatus n. ssp.	Silurian: Cobleskill New York
E. remipes flintstonensis Swartz	Silurian: Tonoloway Maryland
E. remipes quebecensis n. ssp.	Silurian: Gascons Quebec
E. cephalaspis Salter	Silurian ?: Downtonian England
E. sp. Størmer	Devonian: Red Bay Spitzbergen
E. sp. Størmer	Devonian Germany

Genus *Onychopterella:*	
O. pumilus (Savage)	Lower Silurian: Essex Illinois
O. kokomoensis (Miller & Gurley)	Upper Silurian: Kokomo Indiana
Genus *Erieopterus:*	
E. chadwicki (Clarke & Ruedemann)	Ordovician: Normanskill New York
E. hudsonicus (Ruedemann)	Ordovician: Snake Hill New York
E. laticeps (Schmidt)	Silurian: Ludlow Oesel (Saaremaa)
E. pustulosus (Hall)	Silurian: Williamsville New York
E. limuloides (Kjellesvig-Waering)	Silurian: Kokomo Indiana
E. microphthalmus eriensis (Whitfield)	Silurian: Put-in-Bay Ohio
E. hypsophthalmus n. sp.	Silurian: Put-in-Bay Ohio
E. microphthalmus microphthalmus (Hall)	Silurian: Manlius New York
E. latus (Ruedemann)	Devonian: Beartooth Butte Wyoming
E. brewsteri (Woodward).	Devonian: Old Red Scotland
E. statzi (Størmer)	Devonian: Siegener Scotland
Genus *Tylopterella:*	
T. boylei (Whiteaves)	Silurian: Guelph Ontario

Waterston (1957, p. 268) recognizes the genus *Campylocephalus* d'Eichwald, 1860 as a genus of the family Eurypteridae, and gave an excellent description and numerous figures of this peculiar and hitherto rather problematical eurypterid. Prior to Waterston's work, Størmer (1955, p. P39) considered this genus to belong to the family Stylonuridae of the superfamily Stylonuracea. The writer was in agreement with Størmer's classification. In view of Waterston's new findings, the writer is now of the opinion that *Campylocephalus*, on the basis of the very peculiar prosomal legs, as well as the structure of metastoma, and other structures, should merit the establishment of a new family within the superfamily Stylonuracea. Few eurypterids are as distinctly different than those represented by the unique *Campylocephalus* group.

ACKNOWLEDGMENTS

The writer wishes to thank Dr. Carl O. Dunbar, Yale University; Dr. G. Arthur Cooper, U. S. National Museum; Dr. Grace Stewart, Ohio State University; Dr. Winifred Goldring, New York State Museum; Mr. R. Baker, British Museum (N.H.); Dr. C. J. Stubblefield, Geological Survey and Museum (London); Dr. Michael S. Chappers, formerly of the Walker Museum, University of Chicago; Dr. F. W. Shotton,

University of Birmingham; Dr. Robert Denison and Dr. Eugene S. Richardson, Jr., of the Chicago Natural History Museum and Dr. Harold W. Scott of the University of Illinois, for the loan of several of the specimens herein described. To Dr. Donald Baird, the writer is indebted for his kind advice on some taxonomical matters. He also wishes to thank Mr. Willard P. Leutze of Ohio State University for the loan of several important specimens and for data on the stratigraphy of the "Bertie" beds in New York.

SYSTEMATICS

Class MEROSTOMATA Dana
Subclass EURYPTERIDA Burmeister
Superfamily EURYPTERACEA Burmeister
Family EURYPTERIDAE Burmeister, 1845

Small to medium Eurypteracea; prosoma subrectangular to round, compound eyes subcentral, ocelli central, ventral shield composed of two plates, sutured at mid-anterior; chelicerae small, simple; walking legs increase in length posteriorly; swimming leg developed as paddle; metastoma ovate notched or cordate anteriorly; genital appendage: in male, long, with divergent distal spines; female: short, with covered lateral lobes; telson styliform; ornamentation varies from crescentic scales or pointed scales to pustules.

Stratigraphic range: Ordovician to Devonian.

Distribution: Northern North America, Europe.

Genus EURYPTERUS Dekay, 1825

Prosoma subquadrate, with narrow marginal rim; doublure with median suture; walking legs differentiated, anterior three (II to IV) with articulated spines, posterior walking legs (V) long, narrow, without spines except at distad; swimming legs strongly developed; metastoma deeply notched at anterior with small denticles; male genital appendage, long, with divergent, distal spines; female: very small; opisthosoma not contracted; spikelike telson, carinated ventrally.

Type species: Eurypterus remipes DeKay.

Distribution: Northeastern North America and Europe.

Stratigraphic range: Ordovician?, Silurian and Lower Devonian.

Remarks.—The narrow fourth walking leg is a characteristic unknown in any of the Eurypteridae, and surprisingly is known only in *Megalograptus* of the upper Ordovician. Comparison with other genera of the Eurypteridae is discussed in the following descriptions of other genera included in this family. Habitat: Brackish and marine water.

Genus ONYCHOPTERELLA Størmer, 1951

Prosoma subquadrate, walking legs undifferentiated, long, narrow, without spines except at distad; swimming legs inconspicuous, very narrow, pretarsus very long, spikelike, no contraction of opisthosoma; metastoma rounded posteriorly and subcordate anteriorly, genital appendages not well known; telson, spikelike, not carinated ventrally. Ornamentation comprises small, pointed scales.

Type species: Eurypterus kokomoensis Miller & Gurley.

Distribution: Indiana, Illinois.

Stratigraphic range: Silurian.

Remarks.—The genus *Onychopterella*, although without question a member of the Eurypteridae, has a distinct dolichopteroid or stylonuroid aspect because of the long walking legs and greatly elongated, poorly developed, swimming legs. It differs from *Eurypterus* in the lack of differentiation of the walking legs, the inconspicuous and poorly developed swimming legs and the presence of a spurlike pretarsus in the swimming leg. Habitat: Brackish and possibly marine water.

Genus ERIEOPTERUS Kjellesvig-Waering, n. gen.

Prosoma rounded, wide, with small reniform eyes, narrow to wide rim; doublure without median suture, fluted on inner side; walking legs undifferentiated, without spines or only present on distal joints; spines developed as fixed, not movable, spines; swimming leg large, expanded, with pretarsus developed as short spur; metasoma constricted at second tergite; telson spikelike; underside not well known. Ornamentation: smooth or covered with fine to coarse pustules.

Type species: Eurypterus microphthalmus Hall.

Distribution: New York, Ohio, Wyoming, Indiana, Great Britain, Norway, Oesel.

Stratigraphic range: Ordovician to Devonian.

Remarks.—The genus *Erieopterus* differs from *Eurypterus* mainly in the undifferentiation of the walking legs, the spurlike development of the pretarsus, the constriction of the metasoma, and the ornamentation which is smooth or pustular rather than developed as pointed scales. From *Onychopterella* it differs in the wide, rounded carapace, the small eyes, the expanded development of the swimming leg, the constriction of the metasoma and the pustular ornamentation. The peculiar ornamentation of *Tylopterella* will serve to distinguish it from *Erieopterus.*

Habitat: Marine, brackish and fresh water.

Genus TYLOPTERELLA Størmer, 1951

Prosoma rounded with prominent, raised, marginal rim; appendages mainly unknown, opisthosoma constricted, telson spikelike. Underside unknown. Exoskeleton comprises a thickened, partly calcareous, integument. Ornamentation consists of curved ridges of confluent tubercles with a double series of calcareous bosses along the axis of the mesosoma.

Type species: Eurypterus boylei Whiteaves.

Distribution: Ontario.

Stratigraphic range: Silurian.

Remarks.—The peculiar ornamentation of *Tylopterella* is sufficient to distinguish it from any other genus. It is a form particularly adapted for hypersaline conditions as attested by the greatly thickened, partly calcareous, exoskeleton. The rounded prosoma with small eyes, as well as the contracted opisthosoma, reveals affinities more with *Erieopterus* rather than *Eurypterus* or *Onychopterella.*

Habitat: Hypersaline water.

The species of the family Eurypteridae, arranged in alphabetical order, with their synonymies, range, and location, along with descriptions of new species and subspecies, and new morphological details, are given below:

ERIEOPTERUS BREWSTERI (Woodward)

Eurypterus brewsteri WOODWARD, 1864, p. 200, pl. 10, fig. 3; 1864a, p. 73; ——, 1872, p. 151, pl. 28, fig. 4; ——, 1877, p. 64; ——, 1887, p. 481; ETHERIDGE, 1888, p. 145; LAURIE, 1892, p. 159; WOODWARD, 1907, p. 278; CLARKE & RUEDEMANN, 1912, p. 158; O'CONNELL, 1916, p. 39; DIENER, 1924, p. 15; EVANS & STUBBLEFIELD, 1929, p. 145; STØRMER, 1934, p. 19; ——, 1936, p. 33.

The very broad prosoma as well as the small size of the lateral eyes indicate that this species should properly be referred to the genus *Erieopterus.* It is in many respects similar to the Wyoming *Erieopterus latus* (Ruedemann), also a Lower Devonian form. Only one specimen known.

Distribution: Kelly Den, near Arbroath, Scotland.

Stratigraphic range: Lower Devonian, Old Red sandstone.

ERIEOPTERUS CHADWICKI (Clarke & Ruedemann)

Eurypterus chadwicki CLARKE & RUEDEMANN, 1912, p. 413, fig. 95; O'CONNELL 1916, p. 39; RUEDEMANN, 1934, p. 380; DIENER, 1924, p. 16; RUEDEMANN, 1942, p. 25; GOLDRING, 1943, p. 107.

The rounded form of the carapace indicates that this species, known from only one specimen, should properly be referred to the genus *Erieopterus* rather than *Eurypterus.*

Distribution: Catskill, New York, associated with graptolites.

Stratigraphic range: Ordovician: Normanskill shale.

ERIEOPTERUS HUDSONICUS (Ruedeman)

Eurypterus hudsonicus RUEDEMANN, 1934, pp. 374–375, fig. 1; ——, 1942, pt. 2, p. 25.

A single distorted carapace represents our knowledge of the species. The rounded anterior margin and small eyes suggest that this species should be referred to the genus *Erieopterus.*

Distribution: Known only from the excavation for the New York State dam, in Hudson River, two miles south of Mechanicville, New York.

Stratigraphic Range: Ordovician: Snake Hill shale, associated with *Hughmilleria kilfoylei, Lasiograptus eucharis, Lepidocoleus* and *Triarthrus becki.*

ERIEOPTERUS HYPSOPHTHALMUS
Kjellesvig-Waering, n. sp.
(pl. 145, fig. 1; text-figs. 1–4)

The holotype and only known specimen comprises a well preserved dorsal shield exhibiting the entire right side and part of the left side. It is a dorsal impression, uncrushed so that details of the ridges and depressions of the surface are revealed.

The prosoma, roughly rectangular, is unusually broad and short. Lateral margins converge gradually forward to a slight degree. At the antelateral angles the margin is abruptly rounded, becoming truncated at the anterior margin which is approximately parallel to the base. A distinct elevated area occupies the central part of the dorsal shield extending from slightly in front of the lateral eyes backwards to the base. A concave, emarginate area along the anterior margin and anterior central part of the dorsal shield forms a shovellike depression ideally suited for digging or grubbing in the mud or sand (Text-fig. 1).

Away from the sloping, raised, central area, the dorsal shield is greatly flattened so that the depth of the shield on the sides is very thin (see Text-fig. 2). The raised area rises to a height of about 5.0 mm. above the level of the flattened sides.

Several distinct depressions and ridges occur on the raised area of the dorsal shield. The glabellar area comprises a raised, narrow ridge located on the central part of the shield, extending longitudinally from the posterior third almost to the ocellar mound (Text-fig. 1). *Eurypterus* has a similar glabella except that it is considerably wider. Two deeply concave areas distinctly occur in the posterior third of the dorsal shield. These depressions, about three times the size of the lateral eyes, are placed slightly oblique to the base and on each side of the central axis. Similar depressions have been noted on *Hughmilleria*? *prominens* (Hall) and are apparently the point of attachment of strong muscles, probably for the articulation of the large coxae of the swimming legs.

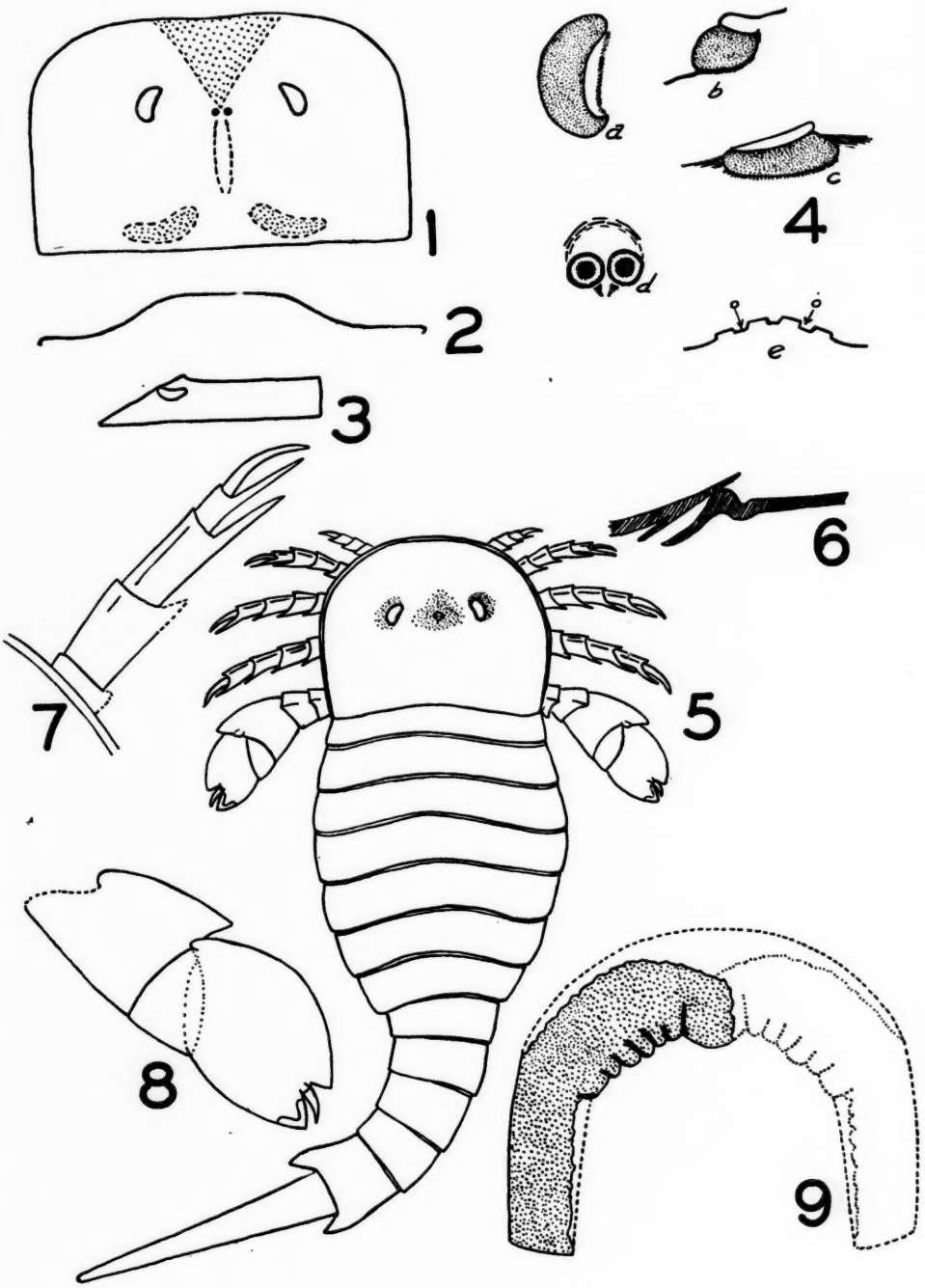
A very narrow marginal rim surrounds the dorsal shield. No ornamentation occurs on the prosoma.

The dorsal shield measures 32.7 mm. in length, 50.8 mm. in reconstructed width at the level of the posterior end of the lateral eyes, and 53.0 mm. in reconstructed width at the base. The ratio between length and width is therefore 6.2:10.

The lateral eyes, small in size, are placed well forward of the middle of the prosoma. They are roughly bean shaped, are placed obliquely on the dorsal shield, and the central part of the visual area points toward the antelateral angles. Each eye protrudes prominently over the surface of the dorsal shield. A narrow palpebral lobe covers only part of the dorsal surface of the visual area. The eyes therefore are capable of forward, lateral, backward, and vertical sight (Text-fig. 4a,b,c).

TEXT-FIGS. *1–9*—Detailed diagrams of eurypterid morphology.

1. Dorsal shield of *Erieopterus hypsophthalmus* Kjellesvig-Waering, n. sp. Darker areas represent depressions; the anterior forms a shovel-like structure ideally suited for grubbing in the mud whereas the posterior depressions appear to represent the areas of attachment of the powerful coxal muscles of the swimming legs, ×1.
2. Cross-section through the width of the dorsal shield of *Erieopterus hypsophthalmus* Kjellesvig-Waering, n. sp. ×1.
3. Lateral view of dorsal shield of *Erieopterus hysophthalmus* Kjellesvig-Waering, n. sp., ×1.
4. Details of the compound eyes and ocelli of *Erieopterus hypsophthalmus* Kjellesvig-Waering, n. sp. a) dorsal, b) posterior, c) lateral, d) ocellar mound and unusually large ocelli, e) cross-section through the ocellar mound ("O" represents the ocelli).
5. Reconstruction of *Erieopterus microphthalmus eriensis* (Whitfield), ×½.
6. Section through the junction of the tergites of *Erieopterus microphthalmus eriensis* (Whitfield) showing posterior doublure and anterior, longitudinal ridge of succeeding tergite (from specimen no. 3510).
7. The third walking leg of *Erieopterus microphthalmus eriensis* (Whitfield). Specimen no. 19614.
8. Distal part, or paddle, of the swimming leg of *Erieopterus microphthalmus eriensis* (Whitfield). Specimen no. 22047.
9. The ventral shield of the prosoma of *Erieopterus microphthalmus eriensis* (Whitfield). Dark area represents part preserved. Specimen no. 19571.


1
2
3
4
a
b
c
d
e
5
6
7
8
9

The visual area is pitted with distinct facets, very small and closely packed. Approximately 100 facets occur to the square millimeter. The lateral eyes measure 4.5 mm. in greatest length, 2.5 mm. in greatest width; are 15.2 mm. apart at their anterior extremities, and are placed on the prosoma 11.00 mm. from the anterior margin, 18.0 mm. from the base, and 1.4.4 mm. from the lateral margin.

Midway between and within a line drawn at the base of the compound eyes is a small, rounded ocellar mound with corresponding ocelli. Each is surrounded by a thick, raised rim giving these usually small structures a considerable prominence on the dorsal shield. The ocelli are placed on the dorsal shield 13.5 mm. from the anterior margin, 24.0 mm. from the lateral margins, and 18.5 mm. from the basal margin. Each slopes away from the other, and are oblique to the surface of the dorsal shield (Text-figures 4d,e.).

Horizon and locality: Silurian. In the Put-in-Bay dolomite at Beach Point, Put-in-Bay Island, Lake Erie, Ohio. On the same slab of dolomite are several fragments of eurypterids, including a fragment of a tergite of *Erieopterus microphthalmus eriensis* (Whitfield).

Depository: No. 19572, Ohio State University Museum, Columbus, Ohio.

Erieopterus hypsophthalmus is the first member of the family Eurypteridae which has the ommatidea of the eyes preserved so that each small facet is distinctly revealed. The small size of these facets (about 100 facets occur in a square millimeter) is perhaps the reason why these structures have never been satisfactorily preserved in other species of the family Eurypteridae. It is probable that the ommatidea of these Eurypteri are too minute for preservation except under very favorable circumstances.

Erieopterus hypsophthalmus differs greatly from other species of the genus. In comparison with *Erieopterus microphthalmus eriensis* (Whitfield) and *E. microphthalmus microphthalmus* (Hall), the main specific differences are that *E. hypsophthalmus* has a broad, distinctly subrectangular prosoma and very prominent ocelli. In the latter, the central part of the dorsal shield is elevated and the lateral and anterior lateral margins are greatly flattened.

E. hypsophthalmus furthermore, has the eyes much farther apart. The coarse pustular ornamentation of *Erieopterus pustulosus* (Hall) easily distinguishes that form from *E. hypsophthalmus*.

Forms such as *Eurypterus dekayi* Hall and *Erieopterus limuloides* (Kjellesvig-Waering) bear some resemblance to *Erieopterus hypsophthalmus* because of their broad dorsal shield. The former are known from nearly complete specimens and undoubtedly differ in many details from the latter. However, in comparison with the parts known of *Eurypterus dekayi* the much broader and more evenly rounded dorsal shield of the latter is sufficient to separate both forms. With regard to *E. limuloides*, the broader dorsal shield and ornamented rim in the latter forms the main differences.

ERIEOPTERUS LATICEPS (Schmidt)

Eurypterus laticeps SCHMIDT, 1883, p. 63–64, pl. 3a, fig. 16, pl. 6, fig. 15; CLARKE & RUEDEMANN, 1912, p. 172; O'CONNELL, 1916, p. 236; STØRMER, 1933, p. 120–122, figs. 1,2; ——, 1934, p. 8; ——, 1938, p. 69; CASTER & KJELLESVIG-WAERING, 1956, p. 25.

Dolichopterus laticeps CLARKE & RUEDEMANN, 1912, p. 261; O'CONNELL, 1916, p. 50; DIENER, 1924, p. 14; STØRMER, 1934a, p. 44; ——, 1934c, p. 8.

Non Erieopterus laticeps (Schmidt): *Eurypterus* (*Dolichopterus*) *laticeps* HOLM, 1898, p. 56, pl. IV, fig. 23 (non 3), pl. 10, fig. 10 = *Dolichopterus størmeri* Caster & Kjellesvig-Waering. *Dolichopterus laticeps* RAW, 1957, p. 166, etc. (= *Eurypterus remipes tetragonophthalmus* Fischer and *Dolichopterus størmeri* Caster & Kjellesvig-Waering).

The confusion attending this well described species was summarized by Caster & Kjellesvig-Waering (1956, p. 25–26) although those two authors misquoted plate 4, figure 23 as plate 4, figure 3 in Holm's 1898 paper in their reference to the holotype of *Dolichopterus størmeri*. The holotype of *E. laticeps* Schmidt and the paratype comprise two carapaces, which are rounded, with small lateral eyes and pustular ornamentation. The border of elongated pustules along the inner edge of the marginal rim is much like *Erieopterus limuloides*. All characteristics described above indicate the genus *Erieopterus* rather than *Eurypterus*.

Distribution: Oesel (Saaremaa) and Ringerlike, Norway.

Stratigraphic range: Upper Silurian: Zone K (Oesel) and Ludlow Zone 9d (Ringerike).

ERIEOPTERUS LATUS (Ruedemann)

Eurypterus latus RUEDEMANN, 1935, p. 138–141, pl. IV, text-figs. 9–12; STØRMER, 1936, p. 33; RUEDEMANN, 1939, card Eurtypterida 10; KJELLESVIG-WAERING & STØRMER, 1952, p. 998; KJELLESVIG-WAERING, 1955, p. 696.

The broad prosoma, small eyes, lack of spines on the walking legs, abrupt contraction of the metasoma and tubercular ornamentation clearly delegate this very distinct species to the genus *Erieopterus*. Only one specimen is known and this was quite fully described by Ruedemann. Adequate measurements of the holotype, however, were not included in the original description. The following data were taken from the holotype:

MEASUREMENTS FROM THE HOLOTYPE OF ERIEOPTERUS LATUS (RUEDEMANN)

Prosoma: Length: 16.5 mm. Width at base: 32.8 mm. Width behind eyes: 28.2 mm.
Lateral eyes are:

From anterior margin:	From posterior margin:	From lateral margin:	Apart at front:	Apart at back:	Length:	Width:
5.8 mm.	7.3 mm.	8.9 mm.	7.0 mm.	8.8 mm.	3.5 mm.	2.5 mm.

Ocelli are located on prosoma:

From anterior margin:	From posterior margin:	From lateral margin:	Diameter:
7.6 mm.	8.7 mm.	13.0 mm.	0.2 mm.

The marginal rim is 0.4 mm. wide at the anterior part of the prosoma.

Length of tergites:	Posterior width of tergites:
No. 1 2.3 mm.	33.0 mm.
No. 2 4.0 mm.	33.6 mm.
No. 3 4.0 mm.	34.5 mm.
No. 4 4.5 mm.	32.8 mm.
No. 5 4.5 mm.	28.5 mm.
No. 6 4.1 mm.	24.0 mm.
No. 7 4.1 mm.	19.7 mm.
No. 8 4.5 mm.	12.1 mm.
No. 9 6.7 mm.	12.0 mm.
No. 10 7.0 mm.	10.3 mm.
No. 11 7.0 mm.	8.6 mm.
No. 12 8.7 mm.	6.8 mm.
Telson Length: Incomplete	Telson width at base: 2.5 mm.

Distribution: Beartooth Butte, Wyoming.

Stratigraphic range: Lower Devonian fish bed, considered to be a brackish or fresh water deposit. Associated with land plants, ostracoderms, sharks, and arthrodires (Bryant, 1934, p. III), *Strobibopterus princetonii* (Ruedemann), *Pterygotus howelli* Kjellesvig-Waering & Størmer, and *Dorfopterus angusticollis* Kjellesvig-Waering.

ERIEOPTERUS LIMULOIDES (Kjellesvig-Waering)
Text-fig. 16

Oncyhopterus limuloides KJELLESVIG-WAERING, 1948, p. 469–472, pl. 72, text-figs. 1,2.

This distinctive species is based on only one well preserved specimen which reveals the general morphological characteristics of *Erieopterus*, namely, the broad prosoma, walking legs without movable spines, and constriction of the metasoma.

Distribution: Kokomo, Indiana.

Stratigraphic range: Silurian, Kokomo dolomite.

ERIEOPTERUS MICROPHTHALMUS ERIENSIS (Whitfield)
Pl. 147, fig. 4, pl. 148, figs. 2–5, text-figs. 5–10

Eurypterus eriensis WHITFIELD, 1882, p. 196; CLAYPOLE, 1884, p. 239, HALL, 1884, p. 29; MILLER, 1889, p. 548; WHITFIELD, 1893, p. 416–417, pl. 1, fig. 31,32; LANE *et al.*, 1909, p. 554; SHERZER & GRABAU, 1909, p. 546; GRABAU & SHIMER, 1910, p. 407, fig. 1707; GRABAU & SHERZER, 1910, p. 208–209, pl. 30, figs. 31,32.

Eurypterus microphthalmus (*partim*) CLARKE & RUEDEMANN, 1912, p. 193–194, pl. 20, figs. 6,7; O'CONNELL, 1916, p. 50.

A number of specimens of this rare eurypterid have been studied which reveal considerable morphological details not previously known, and which led the writer to consider this form as a subspecies distinct from *Erieopterus microphthalmus microphthalmus* (Hall).

The subspecies, in an uncrushed state, is highly arched with an exoskeleton considerably thicker than that of the usual eurypterid but not comparable to the unusual thickness found in *Tylopterella*.

The prosoma is highly arched, very rounded at the anterolateral margins and with obtuse genal angles. A thin marginal rim surrounds the carapace. The lateral eyes are reniform, protruding, very small, obiquely located on the prosoma, approximately as far apart as from the lateral margins and are forward of the middle of the prosoma. A distinct depression (specimen no. 3538) surrounds the visual area of the eyes (Text-fig. 5). The ocelli are very inconspicuous and situated on a very small ocellar mound which is located midway between, and posterior to the middle of, the eyes. A well defined depression, roughly triangular in shape, surrounds the raised ocellar mound and extends nearly to the lateral eyes and forward beyond the anterior end of the eyes.

No ornamentation is present on the prosoma. Uncrushed specimens do not reveal any trace of the glabellar ridge.

The ventral shield of the prosoma, or doublure, consists of a wide, horseshoe-shaped plate without a median suture and with conspicuous fluting along the inner edge, at least along the anterior half of the doublure. A wide rostral area is indicated but no median suture is discernible. The doublure was seen only on one specimen (no. 19571) where it is incompletely preserved (Text-fig. 9, pl. 148, fig. 2). No ornamentation is present on the doublure.

Of the walking legs only the third is preserved (specimen no. 19614), and comprises a stout structure with a single spine, possibly a spur, developed on the distal joints. The last joint is a curved spine (Text-fig. 7). The joints are strengthened by a longitudinal keel.

The swimming leg comprises a very stout structure with a well developed paddle. The

MEASUREMENTS OF SPECIMENS

Prosomal measurements:

Specimen Number	Length	Width at base	Width behind eyes	Ratio
Whitfield's Syntype	27.0 mm.	36.8 mm.		7.3:10
Whitfield's Syntype	24.5 mm.	32.4 mm.		7.6:10
no. 155, 678	25.0 mm.	35.2 mm.	31.4 mm.	7.1:10
no. 19614	10.0 mm.	14.2 mm.	13.2 mm.	7.0:10
no. 19571	22.6 mm.	30.5 mm. est.	28.0 mm.	7.4:10
no. 22047	29.5 mm.	43.0 mm.	39.5 mm.	6.9:10
no. 3532	18.2 mm.	25.0 mm. est.	23.0 mm. est.	7.3:10
no. 3538			23.0 mm.	

Lateral eyes:

Specimen Number	Length	Width	From anterior margin	From posterior margin	From lateral margin	Apart at front	Apart at back
no. 155, 678	3.9 mm.	2.7 mm.	9.0 mm.	12.8 mm.	8.5 mm.	8.0 mm.	9.3 mm.
no. 19614	2.2 mm.	1.5 mm.	3.2 mm.	5.0 mm.	3.4 mm.	3.5 mm.	4.0 mm.
no. 19571	3.4 mm.	2.2 mm.	8.0 mm.	11.7 mm. est.	8.0 mm.		
no. 22047	4.3 mm.	2.2 mm.	11.1 mm.	11.0 mm.	13.7 mm.		
no. 3532	3.2 mm.	2.0 mm.	5.9 mm.	9.0 mm.	6.0 mm.	5.5 mm.	6.8 mm.
no. 3538	3.2 mm.	2.2 mm.	7.2 mm.		7.2 mm.		

Ocellar mound located on prosoma:

Specimen Number	From anterior margin	From posterior margin	From lateral margin
no. 155, 678	11.5 mm.	16.0 mm.	12.8 mm.
no. 19614	4.2 mm.	5.0 mm.	6.0 mm.
no. 3532	8.6 mm.	9.6 mm.	11.5 mm.
no. 3538	10.2 mm.		11.5 mm.

tarsus is particularly large, ovoid, and has a distinct thickened rim, almost a spine, at the distal, posterior end. The pretarsus is developed as a prominent curved spine (Text-figs. 5,8).

The metastoma has not been observed.

The opisthosoma is contracted at the eighth tergite into a distinct abdomen and postabdomen. The first tergite of the mesosoma is considerably reduced. All tergites are bounded by a transverse ridge at the anterior border (Text-fig. 6), sloping forward and abruptly downward and are covered by minute pustules, slightly larger on the anterior than the posterior part of the tergites.

One of Whitfield's syntypes (no. 3510) figured on Pl. 148, Fig. 4, and Text-fig. 10, is mainly broken at the margins but enough is preserved of the ends of the abdominal plates on the left side that a fair estimate can be made of the width of each tergite. The measurements of the mesosoma and metasoma are as follows:

No. 3510, Whitfield's syntype, 1893, pl. 1, fig. 32:

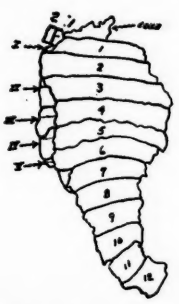
Tergite	Length at center	Width at base
1	4.0? mm.	34.0? mm.
2	6.2 mm.	37.0? mm.
3	7.0 mm.	44.0? mm.
4	7.0 mm.	43.0? mm.
5	7.1 mm.	35.0 mm. estimated
6	7.0 mm.	32.0 mm. estimated
7	7.2 mm.	27.0 mm. estimated
8	7.2 mm.	18.5 mm. estimated
9	7.2 mm.	16.0 mm. estimated
10	8.5 mm.	14.0 mm. estimated
11	8.5 mm.	12.0 mm. estimated
12	10.0 mm.	14.0 mm. estimated

Another specimen (no. 22047), the largest known, reveals the reduction of the first tergite better than the above specimen:

Tergite	Length at center
1	3.7 mm.
2	6.5 mm.
3	6.5 mm.

The mesosoma of the smallest specimen (no. 19614) known, (Pl. 147, fig. 4), measures as follows:

Tergite	Length at center
1	1.7 mm.
2	2.6 mm.
3	2.8 mm.
4	2.8 mm.
5	2.8 mm.



TEXT-FIG. *10*—Outline drawing of specimen of *Erieopterus microphthalmus eriensis* Whitfield. This is the same specimen figured on plate 148, figure 4. ×½. Nos. 1–12 are the tergites; I to V represent the ventral, abdominal plates.

The underside of the mesosoma is almost unknown. The operculum is preserved only in one specimen (no. 22046) which is a female having a short median appendage. However, this is much too poorly preserved to enable a description. A transverse suture is developed along the middle of the opercular plates much as in *Eurypterus* and others.

The telson is developed as a stout spike, the anterior part of which has been noted (Text-fig. 5).

Horizon and locality: All specimens reported here are from the Silurian: Put-in-Bay Dolomite member of Bass Islands Dolomite at Beach Point, Put-in-Bay Island, Ohio except specimen no. 19,614 which is from the same horizon at South Bass Island, Ohio (collected by David Stansbury), and specimens no. 22046 and no. 22047 which are labeled "Put-in-Bay Dolomites, northern Ohio." The latter were collected by C. S. Prosser.

The intimate association (on the same slab as the eurypterids) of definite marine fossils, such as abundant brachiopods and ostracodes, leave no doubt that burial of the eurypterids was in a marine environment. The rather thick exoskeleton of *E. microphthalmus eriensis*, very probably reinforced by calcium carbonate, is considerably different from the thin integument present in most of the Eurypterida, and suggests that this species was a Marine form. Similar ecological association and integumentation are found in *Erieopterus microphthalmus* (Hall) from the Manlius waterlime of New York. An extreme case of thick-

ening of the exoskeleton as well as reinforcement by calcium carbonate is found in *Tylopterella boylei* (Whiteaves) which is known to have withstood hypersaline conditions.

Repository: Whitfield's (1884) syntypes are in the Geological Museum, Columbia University; another syntype, Whitfield's 1884, and 1893, Pl. 1, fig. 32, specimen no. 3510, described in this paper, is deposited in the collections of the Geological Museum, Ohio State University. Specimens no. 3511, 3532, 3538, 19571, 19614, 22046, and 22047 are also at Ohio State University. no. 155678 is in the collections of the U.S. National Museum.

Remarks.—Clarke & Ruedemann (1912, p. 193), consider *Eriopterus microphthalmus eriensis* (Whitfield) to be identical to *Erieopterus microphthalmus microphthalmus* (Hall) from the Manlius limestone of New York. The two forms are similar in many respects but certain definite differences are present, particularly in the new material reported in this paper regarding both forms. *Erieopterus microphthalmus eriensis* is completely devoid of any ornamentation on the prosoma whereas *E. microphthalmus microphthalmus* has distinct pustules on the prosoma (Pl. 147, fig. 2). The prosoma of the former is consistently narrower, having a length to width ratio (seven specimens known) ranging from 6.9 to 7.6:10, whereas the eight known specimens of *E. microphthalmus microphthalmus* reveal a range in the ratio of 6.4 to 7.2:10. The anterior transverse ridges on the tergites of *E. microphthalmus eriensis* are more prominently developed than in *E. microphthalmus microphthalmus*. The paddle of the former likewise is shorter and stouter than the latter. Although only the base of the telson is known in *E. microphthalmus eriensis*, it is likely that this structure is not as long as in *E. microphthalmus microphthalmus*. These differences are small, but nevertheless significant, and probably of subspecific value.

ERIEOPTERUS MICROPHTHALMUS MICROPHTHALMUS (Hall)

Pl. 147, figs. 1–3; text-fig. 11.

Eurypterus microphthalmus HALL, 1859, p. 407, fig. 7; MILLER, 1877, p. 217; HALL, 1884, p. 29; MILLER, 1889, p. 548; WHITFIELD, 1893, p. 417; CLARKE, 1909, p. 37; CLARKE & RUEDEMANN, 1912, p. 192, pl. 20, figs. 2–5,8–10; WOODWARD, 1913, p. 297; O'CONNELL, 1916, p. 40; DIENER, 1924, p. 18; DEHEE, 1928, p. 324; STØRMER, 1934, p. 19; ——, 1936, p. 33; SHIMER & SHROCK, 1944, p. 707, pl. 299, figs. 12,13; KJELLESVIG-WAERING, 1948, p. 466.

Eurypterus microphthalmus Clarke & Ruedemann VAN OYEN, 1956, p. 54.

Non Erieopterus microphthalmus microphthalmus (partim) (Hall).

Eurypterus microphthalmus CLARKE & RUEDEMANN, 1912, p. 193–194, pl. 20, figs. 6,7.

(=*Erieopterus microphthalmus eriensis* (Whitfield)

Erieopterus microphthalmus microphthalmus (Hall) is a relatively rare eurypterid, but to date four dorsal shields and one nearly complete specimen retaining the dorsal shield, mesosoma and metasoma, are known (Clarke & Ruedemann, 1912, p. 192). All specimens are from the Manlius limestone.

Two dorsal shields hitherto unreported, and figured on Pl. 147, Figs. 1–3, reveal additional information concerning this rare eurypterid. One of these shields is by far the largest known for the species and furthermore retains the ornamentation which was previously unknown. Both specimens were found in the Manlius limestone, near the Olney and Elmwood "A" contact on a talus slope on the north side of Split Rock Quarries, Syracuse, New York. Both specimens are associated with brachiopods and ostra

---

EXPLANATION OF PLATE 143

FIG. *1*—*Eurypterus remipes remipes* DeKay. Dorsal side of well preserved specimen from the Fiddlers Green dolomite at Jerusalem Hill, Herkimer County, New York. Jewett Collection, No. 9003A, Peabody Museum of Natural History, Yale University, ×$\frac{5}{6}$.

2—Paddle of swimming leg of *Eurypterus remipes remipes* DeKay from ventral side. Same horizon and location as figure *1*. Jewett Collection, No. 9003B, Peabody Museum of Natural History, Yale University, ×1.5

3—Paddle of swimming leg of *Eurypterus remipes swartzi* Kjellesvig-Waering, n. ssp., holotype, ×1.7, from the Wills Creek shale, Riverside, West Virginia.

1

2

3

1

cods. These were collected by M. Wm. Pullen, Jr. on May 4, 1939 and are deposited in the Geological Department Collection of Syracuse University.

One of these shields (Pl. 147, fig 1) comprises an external mold with the ocelli and ornamentation not apparent. It measures 36 mm. in length and 56 mm. in estimated width. The small compound eyes measure 5 mm. in length and are located on the prosoma 12 mm. from the anterior margin, 13 mm. from the lateral margin, 19 mm. from the posterior margin and are 13 mm. apart. On the same slab is a fragment of a tergite, 13 mm. in length, which retains ornamentation of the same type as that occurring on the dorsal shield described below.

The other carapace is the largest known for this species, and consists of an external mold, retaining the ornamentation but not the ocelli (Pl. 147, figs. 2,3.) This shield measures 46 mm. in length and 71 mm. in width along the base. The compound eyes are 6 mm. in length and are located on the dorsal shield 16 mm. from the anterior margin, 18.2 mm. from the lateral margin, 24 mm. from the posterior margin, and are 20 mm. apart. It is covered with small, round, evenly distributed pustules (Pl. 147, fig. 2). Hitherto the ornamentation of this form was unknown.

A specimen of considerable importance was lately discovered by Willard P. Leutze of Ohio University (Text-fig. 11). It is a dorsal impression, nearly complete, retaining the prosoma with appendages and the complete opisthosoma including the telson. It is from the Manlius (Olney? float) at Split Rock Quarry, Syracuse, New York. It is a rather young individual as attested not only by its small size, but by the great enlargement of the swimming legs. The specimen retains parts of the walking legs (appendages III, IV, V) on the right side which are revealed as undifferentiated structures with a single spur (not movable spine) at the base of each joint.

For comparative purposes, the measurements of this excellent specimen are as follows:

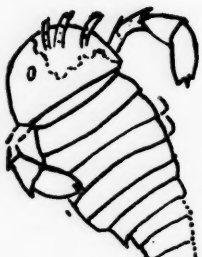
Prosoma:	
Width at base:	15.9 mm.
Width behind eyes:	14.4 mm.
Length behind eyes:	10.9 mm.
The lateral eyes are located on the prosoma:	
From anterior margin:	3.5 mm.
From posterior margin:	5.4 mm.
From lateral margin:	3.5 mm.
Length of lateral eyes:	1.8 mm.
Width of lateral eyes:	1.1 mm.
The ocellar mound is located on the prosoma:	
From anterior margin:	4.8 mm.
From posterior margin:	5.4 mm.
From lateral margin:	6.8 mm.
Length of tergites:	
No. 1	1.3 mm.
No. 2	2.3 mm.
No. 3	2.6 mm.
No. 4	2.6 mm.
No. 5	2.6 mm.
No. 6	2.6 mm.
No. 7	2.6 mm.
No. 8	2.6 mm.
No. 9	3.0 mm.
No. 10	3.0 mm.
No. 11	3.6 mm.
No. 12	4.8 mm.
Width of tergites (at posterior):	
No. 1	14.0 mm.
No. 2	15.0 mm.
No. 3	15.4 mm.
No. 4	14.0 mm.
No. 5	13.7 mm.
No. 6	12.2 mm.
No. 7	10.0 mm.
No. 8	7.9 mm.
No. 9	7.5 mm.
No. 10	6.3 mm.
No. 11	5.3 mm.
No. 12	4.4 mm.
Telson:	
Length:	17.0 mm.
Width at base:	2.9 mm.

It should be noted that the basal part of the carapace is considerably wider than the succeeding tergite. This is due to the specimen's being preserved in a flattened state

---

EXPLANATION OF PLATE 144

FIG. 1—Ventral aspect of *Eurypterus remipes remipes* DeKay, a male, from the Fiddlers Green dolomite at Jerusalem Hill, New York (from the Jewett Collection No. 9003B, Peabody Museum of Natural History, Yale University), ×1.



TEXT-FIG. *11*—Outline drawing of small, nearly complete specimen of *Erieopterus microphthalmus microphthalmus* (Hall). From drawing by W. P. Leutze. ×1.

and indicates that the carapace of this species was highly arched in life.

The swimming legs, greatly enlarged, terminate in a pointed spur as in other species of *Erieopterus* and *Onychopterella*. The length of the sixth joint at midsection measures 4.0 mm., and 3.9 mm. in width also at the central part. The seventh joint, constituting the rest of the paddle, is 5.0 mm. long at midsection and 3.3 mm. wide. *Crispella vanuxemi* (Hall) occurs on the same slab as the eurypterid. No ornamentation is discernible on this specimen, although the large adult carapace described above and figured on Pl. 147, Fig. 2, preserved in a similar state and from the same locality, clearly reveals pustular ornamentation. It may well be that ornamentation is not developed in this subspecies until maturity.

Because of the apparent similarity of the dorsal shields of *Erieopterus microphthalmus* (Hall) and *E. eriensis* (Whitfield), Clarke & Ruedemann (1912, p. 195) considered both to represent the same species. For reasons discussed on page 1116, this writer treats both as separate subspecies.

Horizon and locality: Occurs in the Manlius limestone at Cranes Corners, Herkimer County; Cazenovia, Litchfield and Syracuse, New York.

ERIEOPTERUS PUSTULOSUS (Hall)

Eurypterus pustulosis HALL, 1859, p. 413, pl. 83B, fig. 1; MILLER, 1877, p. 217; HALL, 1884, p. 29; MILLER, 1889, p. 548; GRABAU, 1901, p. 229; CLARKE, 1909, p. 37; CLARKE & RUEDEMANN, 1912, p. 201–207, pl. 23, figs. 1,2, pl. 24, figs. 1–4; text-figs. 39–41; WOODWARD, 1913, p. 298, O'CONNELL, 1916, p. 40; DIENER, 1924, p. 19; STØRMER, 1933, p. 122; KJELLESVIG-WAERING, 1948, p. 466; CASTER & KJELLESVIG-WAERING, 1956, p. 19

Eurypterus giganteus POHLMAN, 1883, p. 41, pl. 2, fig. 1: MILLER, 1889, p. 548.

Pterygotus globicaudatus POHLMAN, 1883, p. 42, pl. 2, fig. 2; MILLER, 1889, p. 564; LAURIE, 1893, p. 515; GRABAU, 1901, p. 231; CLARKE, 1909, p. 37.

Clarke & Ruedemann (1912, p. 201) correctly referred *Eurypterus giganteus* Pohlman and *Pterygotus globicaudatus* Pohlman as synonyms of *Eurypterus pustulosus* Hall. This rare species is the largest form of the family Eurypteridae and one of the most striking and unusual eurypterids known. A fragment of a prosoma indicates that this species reached a length of one meter, a size which is unique in the family Eurypteridae. The small size of the eyes, the very broad and rounded prosoma, the abrupt contraction of the metasoma and the very coarse, pustular ornamentation clearly reveal this form as an extreme development of the morphological characteristics of the Genus *Erieopterus*. The extreme development of these characters easily distinguishes it from other forms of the genus.

Distribution: Buffalo, Erie County, New York.

Stratigraphic range: Silurian; occurs in the Williamsville dolomite member of the Bertie formation.

ERIEOPTERUS STATZI (Størmer)

Eurypterus statzi STØRMER, 1936, p. 54–56, pl. 7, fig. 3.

The species is based on a single specimen retaining the prosoma, with attached swimming leg, and the mesosoma. The shape of the prosoma, lack of ornamentation, the spur-like transtarsus (8th joint) and highly serrated paddle (6th and 7th joint) indicate that this form should be referred to the genus *Erieopterus*.

Distribution: Wahnbachtal, near Siegburg, Germany.

Stratigraphic range: Lower Devonian; upper Siegener sandstone.

EURYPTERUS CEPHALASPIS Salter

Homalonotus? cephalaspis SALTER *in* BURMEISTER, 1846, p. 125 (*nomen nudum*).

Eurypterus cephalaspis SALTER *in* SEDGWICK & McCOY, 1855, p. v, pl. 1E, fig. 21; McCOY, 1855, p. 175; BIGSBY, 1859, p. 321; WOODWARD, 1877, p. 64; ETHERIDGE, 1888, p. 52; O'CONNELL, 1916, p. 39; KING, 1934, p. 563.

Eurypterus linearis SALTER, 1859, p. 234, pl. 10, figs. 15,15a and b; BIGSBY, 1859, p. 321; 1864, p. 107; ——, 1872 (1866–78), p. 147–148, pl. 28, figs. 10–12; MARSTON, 1870, p. 409; WOODWARD, 1877, p. 65; SCHMIDT, 1883, p. 50; ETHERIDGE, 1888, p. 53; ELLES & SLATER, 1906, p. 220; O'CONNELL, 1916, p. 40; LAURIE, 1895, p. 158; DIENER, 1924, p. 17; KING, 1934, p. 563.

Eurypterus brodiei WOODWARD, 1871, p. 261–263; fig. 1 (*non* figs. 2,3); WOODWARD, 1871, p. 161–163, fig. 53; ——, 1877, p. 64; ETHERIDGE, 1888, p. 52; WOODWARD, 1907, p. 278; O'CONNELL, 1916, p. 39; DIENER, 1924, p. 16; KING, 1934, p. 563; STØRMER, 1934, p. 19; STØRMER, 1936, p. 33; KJELLESVIG-WAERING, 1951, p. 17–21, pl. 3, fig. 1, text-fig. 21.

Hugimilleria linearis STØRMER, 1934d, p. 6.

Hughmilleria (?) *linearis* STØRMER, 1934a, p. 83; KJELLESVIG-WAERING, 1950, p. 228.

The holotype, a carapace, was intended by Salter to be described as a trilobite, *Homalonotus? cephalaspis* (Salter, 1846, p. 125). Later the species was figured and described by M'Coy (1855, p. 175) who credits Salter with the species, and by Salter in an appendix of the same publication (1855, p. v, pl. 1E) which undoubtedly represents the original description. The holotype was from the Downtonian quartzites of Kirkby Moor, Kendal, Westmoreland. Not long after, Salter (1859, p. 234, pl. 10, figs. 15,16a and b) described three telsons under the name of *Eurypterus linearis*, from the Downtonian and Upper Ludlow (?), Kington and Ludford Lane. Woodward followed in 1871 with the description of a nearly complete form as *Eurypterus brodiei*, from the Downton sandstone at Perton near Stoke Edith, Herefordshire. Much later, Kjillesvig-Waering (1951) restudied the Perton material, added more specimens of *E. brodiei* Woodward, and corrected some minor misconceptions in Woodward's original description which included parts of *Hughmilleria banksii* (Salter).

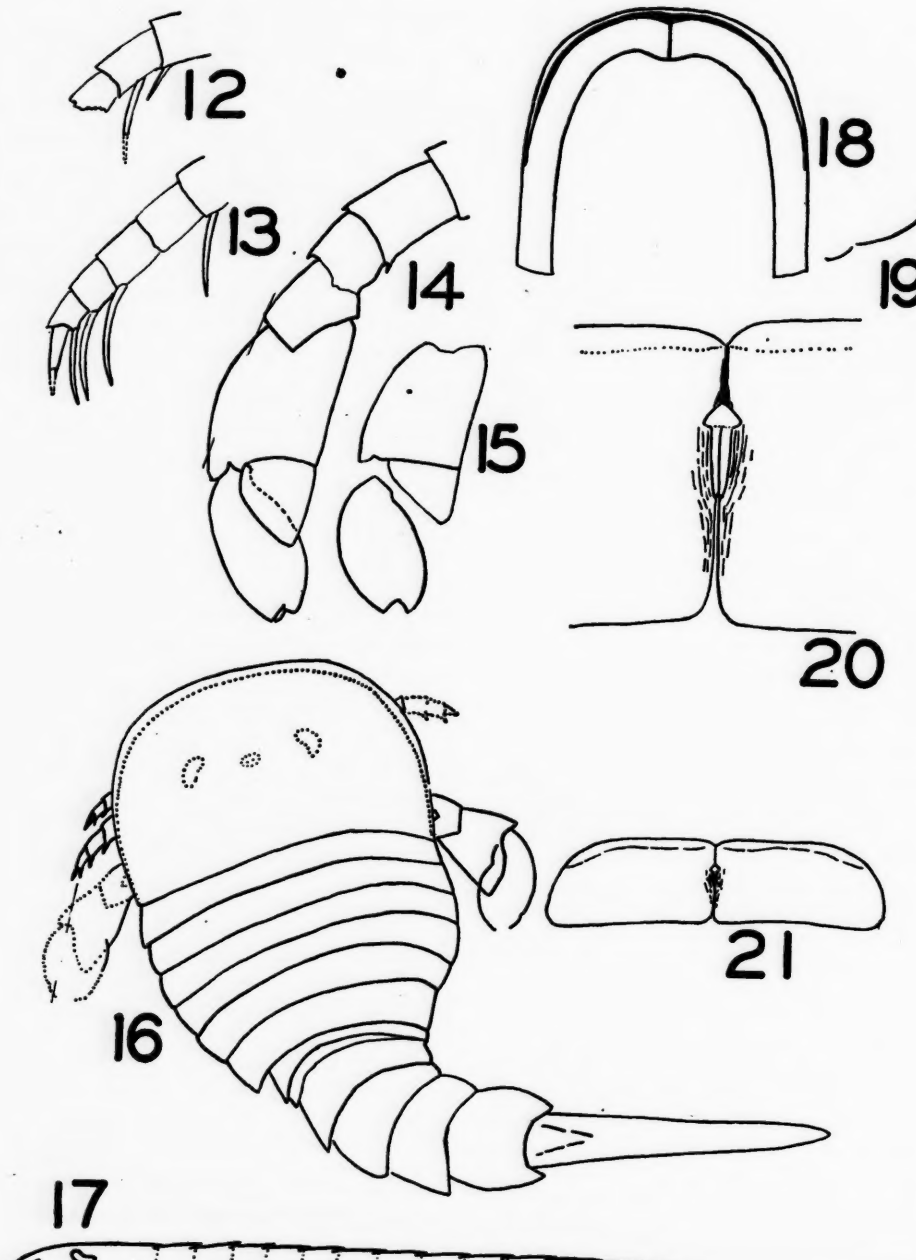
Recently the writer was given the opportunity of restudying the original collections made by Banks, Marston, Lightbody, etc., which had been used by Salter and Woodward in their early descriptions of many of the well known Upper Silurian eurypterids of the Welsh Borderland, and which now are in the collections of the British Museum (N. H.) and the Geological Survey and Museum. These revealed that *E. linearis* was the same species as *E. cephalaspis* but further showed clearly that *E. brodiei* was a synonym of the above Salter species. Inasmuch as *E. cephalaspis* Salter (1855) has clear priority over *E. linearis* Salter (1859), the former is the correct name to use. The evidence, in detail, will be presented by the writer in a forthcoming paper on the Downtonian eurypterids of the Welsh Borderlands.

Distribution: Westmorland, Herefordshire, and Shropshire, England.

Stratigraphic range: The holotype is from the Downton sandstone, at Kirkby Moor, Kendal, Westmorland. The holotype and two paratypes of *E. linearis* are from the upper Ludlow (?) at Ludford Lane, Ludlow, and the Downton sandstone at Kington, Herefordshire. The writer has further identified this species from the Temeside Shales (Olive shales), Tin Mill Race, near Downton Castle, Herefordshire (Chicago Nat. Hist. Mus. PE 5124); from the Downtonian at Onibury, five miles northwest of Ludlow, Shropshire (Geol. Survey and Mus. no. 89445); two specimens from the Downtonian at Kington, Herefordshire (Geol. Survey and Mus. no. 89473 and no. 89484); three specimens from the base of the Downton sandstone at Ludford Lane, Herefordshire (British Mus. no. In44570 (2) and In44574); from the Downtonian at Bradnor Hill, Kington, Herefordshire (Birmingham Univ. no. BU-22); from the Downtonian, Temeside shale at the railway cutting at Ludlow, Shropshire (British Mus. no. In44557); another specimen from the Downton sandstone at Bradnor Hill, Kington, Herefordshire (Birmingham Univ. BU-29); and another specimen labeled as "Downtonian at Ludford Lane, Ludlow, Shropshire" (Geol. Survey and Mus. no. 89425).

He has also identified the species in the lower Downtonian at Perton, near Stoke Edith, Herefordshire (as *Eurypterus brodiei*) Kjellesvig-Waering, 1951, p. 17–21).

Eurypterus cephalaspis therefore appears to be restricted to the Downtonian except for one questionable record.



TEXT-FIGS. *12–21*—Detailed diagrams of eurypterid morphology.
12. Second walking leg of *Eurypterus remipes swartzi* Kjellesvig-Waering, n. ssp., holotype, ×1.5.
13. Third walking leg of *Eurypterus remipes swartzi* Kjellesvig-Waering, n. ssp., holotype, ×1.5.
14. The swimming leg of *Eurypterus remipes swartzi* Kjellesvig-Waering, n. ssp., holotype, ×1.5.

EURYPTERUS (?) DECIPIENS Ruedemann

Eurypterus decipiens RUEDEMANN, 1942, p. 28, fig. 4; fig. 6, (1).

The species is represented by a single, poorly preserved specimen retaining the carapace, a fragment of the left swimming leg and part of the mesosoma. The centrally located compound eyes suggest that the species belongs within the family Eurypteridae but its relationship on the generic level is obscure.

Horizon and locality: Ordovician: Normanskill grit (Austin Glen member) along Onesquethaw Creek near base of Callanan's quarry, South Bethlehem, Albany County, New York.

EURYPTERUS CYCLOPHTHALMUS Laurie

Eurypterus cyclophthalmus LAURIE, 1892, p. 158–159, pl. III, fig. 15; PEACH & HORNE, 1899, p. 594; O'CONNELL, 1916, p. 39; DIENER, 1924, p. 16; KING, 1934, p. 563.
Eurypterus (?) cyclophthalmus LAMONT, 1955, p. 200.

Little is known of this species which is based on a small, nearly complete specimen retaining the dorsal side. The lack of any constriction of the metasoma indicates that this is a typical *Eurypterus*. It differs from the associated *Eurypterus minor* in having the prosoma more rounded at the anterior part.

Distribution: Gutterford Burn, Pentland Hills, Scotland.

Stratigraphic range: Silurian, Gala-Tarannon beds, *Monoclimacis crenulata* Zone (Lamont, 1955, p. 200).

EURYPTERUS DEKAYI Hall

Eurypterus dekayi HALL, 1859, p. 411, pl. 82, fig. 1; MILLER, 1877, p. 217; HALL, 1884, p. 29; GRABAU, 1901, p. 230; CLARKE, 1903, p. 711; GRABAU & SHIMER, 1910, p. 409; CLARKE & RUEDEMANN, 1912, p. 181–184, pl. 19, fig. 2; pl. 20. fig. 1; WOODWARD, 1913, p. 297; O'CONNELL, 1916, p. 39; DIENER, 1924, p. 16; KEJLLESVIG-WAERING, 1948, p. 466; CASTER & KJELLESVIG-WAERING, 1956, p. 19.

This is a very rare but highly distinctive species. It is still known from only two nearly complete specimens but differs from all other species of the genus in the great breadth of the prosoma, and in particular in the presence of four spines on each joint of the walking legs. Other differences, of lesser importance such as the very broad paddle and details of the pretelson and telson readily distinguish it from *Eurypterus remipes lacustris* with which it is associated.

Distribution: Black Rock and Buffalo, Erie County, New York.

Stratigraphic range: Silurian: Williamsville member of the Bertie formation.

EURYPTERUS MINOR Laurie

Eurypterus minor LAURIE, 1898, p. 587–588, pl. 5, figs. 27–29; PEACH & HORNE, 1899, p. 594; CLARKE & RUEDEMANN, 1912, p. 132; O'CONNELL, 1916, p. 40; DIENER, 1924, p. 18; KING, 1934, p. 563; LAMONT, 1955, p. 200.

The species is very distinct: Based upon three specimens comprising a nearly complete individual, a prosoma, and the posterior part of the metasoma and telson, it exhibits characteristics typical of the genus *Eurypterus*. This is in opposition to the views of Clarke & Ruedemann (1912, p. 132), who indicate a relationship of this species to *"Eurypterus" maria* Clarke = *Parahughmilleria maria* (Clarke) *"Eurypterus" pygmaeus* Woodward = *Hughmilleria pygamaea* (Woodward), and *Parahughmilleria salteri* (Kjellesvig-Waering). In a forthcoming paper on the eurypterids

---

15. The distal part of the swimming leg of *Eurypterus remipes remipes* DeKay introduced for comparison (from Clarke & Ruedemann, 1912).
16. The holotype of *Erieopterus limuloides* Kjellesvig-Waering, ×⅔. The lateral eyes and ocelli are inferred as they were not preserved.
17. Cross-section through *Eurypterus remipes lacustris* Harlan to show relationship of dorsal to ventral structures, ×½.
18. Ventral shield of *Eurypterus remipes remipes* DeKay showing split along the inner margin made during ecdysis. This specimen is illustrated on plate 145, fig. 3.
19. Cross-section through the anterior part of the ventral shield of the specimen illustrated in Text-fig. 18 to show marginal rim and form of the rest of the shield in an uncrushed condition.
20. Details of female mesial appendage of *Eurypterus pittsfordensis* Sarle, ×4.5. Specimen No. 2 in the writer's collection.
21. The entire operculum of the female of *Eurypterus pittsfordensis* Sarle, ×1.5. Specimen No. 2 in the writer's collection.

from the Downtonian of the Welsh Borderlands, the writer presents evidence that *Eurypterus pygmaeus* is based on two distinct forms, one of which represents a new genus. The quadrate form of the prosoma, prosomal appendages and lack of constriction of the metasoma are characteristics of a typical Eurypterus; a form close to the *Eurypterus remipes* group.

Distribution: Gutterford Burn, Pentland Hills, Scotland.

Stratigraphic range: Silurian: Gala-Tarannon (*Monocolimacis crenulata* Zone) Gutterford Burn flagstones (Lamont, 1955, p. 200).

EURYPTERUS PITTSFORDENSIS Sarle
Pl. 145, figs. 4,5; pl. 148, figs. 6,7; text-figs. 20–26

Eurypterus pittsfordensis SARLE, 1902, p. 1098, pl. 10, fig. 7; pl. 15, figs. 1–3; pls. 16–23; pl. 24, figs. 2,5, & 6: CLARKE, 1909, p. 37; GRABAU, 1910, p. 407, fig. 1706; CLARKE & RUEDEMANN, 1912, p. 196–199, pl. 13, figs. 4–6; pls. 14–16; pl. 17, figs. 1–6; pl. 18, figs. 3–8; WOODWARD, 1913, p. 298; O'CONNELL, 1916, p. 40; RUEDEMANN, 1919, p. 206; DIENER, 1924, p. 18; GRABAU, 1928, p. 368, fig. 1230b; KINDLE, 1934, p. 44; CASTER & KJELLESVIG-WAERING, 1955, p. 1042.

This form is comparatively rare and has been adequately described by Sarle (1902) and Clarke & Ruedemann. Remarks here are therefore directed to the description of additional morphological details either not previously known or incompletely defined. Two specimens (Pl. 148, figs. 6 and 7) from the original Sarle collection reveals such data and are responsible mainly for the reconstruction of the species given in Text-fig. 22.

Specimens no. 1 and 2, at present in the writer's collection, reveal the doublure of the prosoma. As in *Eurypterus remipes remipes* it comprises two plates joined by a median suture at the anterior midsection. A distinct marginal rim surrounds the doublure. The median suture does not extend through the marginal rim (Text-fig. 26).

The metastoma (Text-figs. 24,25) is very well preserved in both specimens, where it is revealed as ovoid, truncated at the base, deeply notched at the anterior end and reaching its greatest width approximately at midsection. The structure in specimen no. 1 (Pl. 145, figs. 4 and 5) is bowed inward through the central axis having a distinct depression at the anterior end. Three to four distinct, striated, small denticles occur on each side of the anterior notch (Text-fig. 25 and Pl. 145, fig. 5).

The female appendage (Text-figs. 20 and 21) is also well preserved in specimen no. 1. This structure is seen from the interior, dorsal side, and consists of a very small median appendage distinctly comprised of two lanceolate pieces. Above these is a wider area which may represent another joint but it is not clearly defined. The medium division between the two lanceolate structures is however clearly apparent. The transverse suture of the operculum was not visible although several indistinct lines are present. The anterior suture however is clearly defined. The abdominal plates are sutured at midsection. This suture is well defined on all but the last abdominal plate where it is present only on the anterior half of the plate.

The entire swimming leg is present in specimen no. 2 and reproduced in Text-fig. 24. It comprises a stout paddle somewhat like *Eurypterus remipes remipes* DeKay although the joints between the paddle and coxa are not as long. The coxa is quadrate in general form.

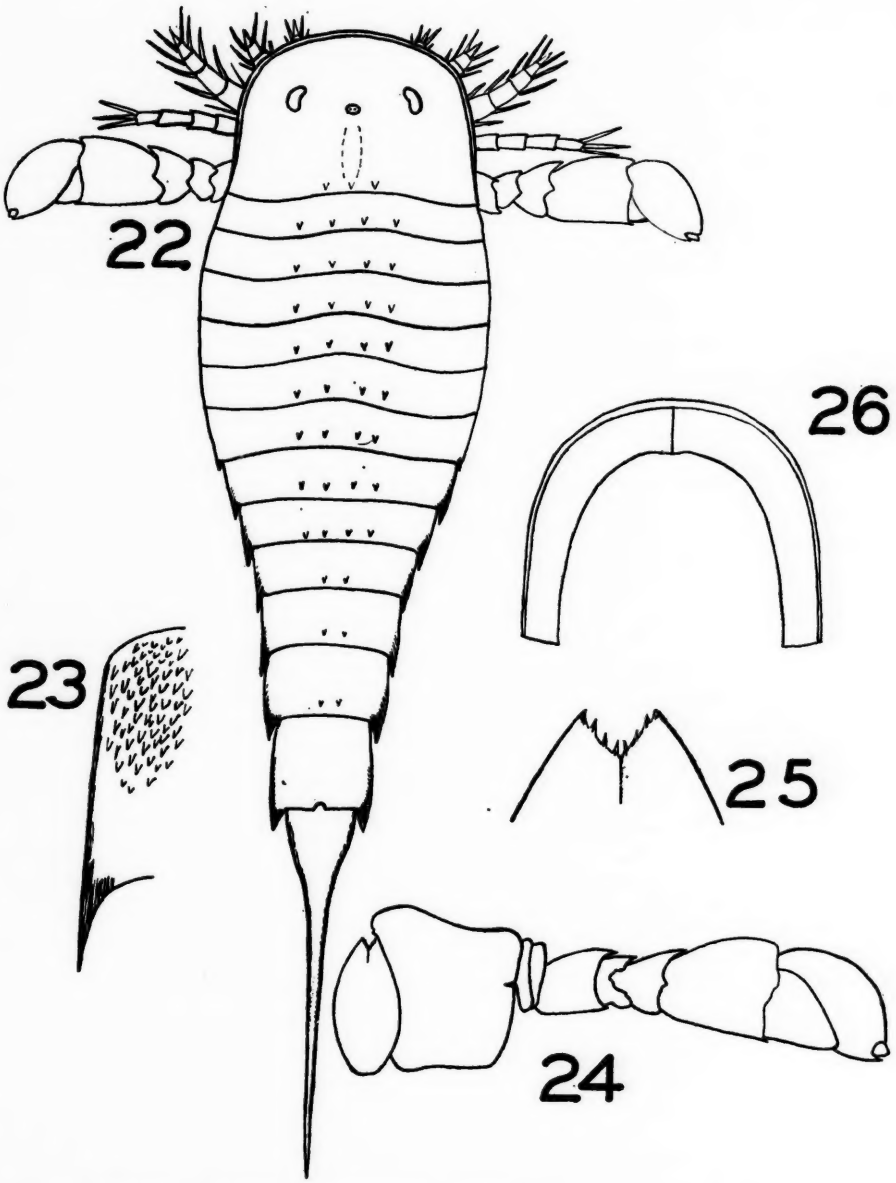
The telson (Pl. 148, fig. 6) is an unusually long spike, bulbous at the anterior part and narrowing into a sharp pointed structure. It has a flat carina on the ventral side and is bordered by a very narrow, flat area with elongated scales or striations.

Striations on the tergites are well developed on the long epimeral horns (Text-fig. 23).

Horizon and locality: Sarle's types come from the Silurian, Pittsford shale at Pittsford, Monroe County, New York. Ruedemann (1919, p. 206) has identified this form also in the lower Vernon shale at Pittsford, New York.

Repository: The two specimens herein described (Pl. 148, figs. 6 and 7) are at present in the writer's collection (nos. 1 and 2).

Remarks.—The reconstruction given on Text-fig. 22 is complete except for the fourth walking leg which is mainly unknown. The species is easily recognizable from any other *Eurypterus* mainly by the presence of pronounced epimeral spurs and the unusually long telson. It is a very distinct and easily recognizable form.



TEXT-FIGS. *22–26*—Detailed diagrams of eurypterid morphology.

22. Reconstruction of dorsal side of *Eurypterus pittsfordensis* Sarle, ×½.

23. Details of the lateral area of a metasomatic tergite of *Eurypterus pittsfordensis* Sarle to show the striations of the epimeral horns and nature of the ornamentation. From specimen No. 1 in the writer's collection.

24. The metastoma and complete swimming leg of *Eurypterus pittsfordensis* Sarle, ×1.5. From specimen No. 2 in the writer's collection.

25. The anterior part of the metastoma of *Eurypterus pittsfordensis* Sarle revealing the anterior denticles and the anterior depression (suture?). From specimen No. 2 in the writer's collection.

26. The ventral shield of *Eurypterus pittsfordensis* Sarle. From specimen No. 2 in the writer's collection.

EURYPTERUS (?) PRISTINUS Clarke & Ruedemann

Eurypterus pristinus CLARKE & RUEDEMANN, 1912, p. 207–208, pl. 83, figs. 5,6; RUEDEMANN, 1912, p. 42,46,49; WOODWARD, 1913, p. 297; O'CONNELL, 1916, p. 40; DIENER, 1924, p. 18; RUEDEMANN, 1934, p. 380; RUEDEMANN, 1942, p. 26.

The species is based on a single carapace exhibiting the quadrate form common to the genus *Eurypterus* but ornamentation which does not suggest that genus. More material is needed to define finally the taxonomic position of this species.

Distribution: Schenectady, New York.

Stratigraphic range: Ordovician: Schenectady shale.

EURYPTERUS REMIPES FLINTSTONENSIS Swartz

Eurypterus flintstoneneis SWARTZ, 1923, p. 716, pl. lxvi, fig. 1; WOODWARD, 1914, p. 263; KJELLESVIG-WAERING, 1950, p. 226.

This is the southernmost occurrence of a typical *Eurypterus* in North America. It is clearly a form which should be included as a subspecies in the *Eurypterus remipes* group; the prosoma indicates a form very close to *Eurypterus remipes lacustris* from which it differs only in the more quadrate form of the prosoma; and differs from *Eurypterus remipes remipes* only in the slightly broader prosoma. Both differences are minor, and it may well be that when more specimens are known that it will be found to be the same as one of the New York forms. At the present, only the holotype is known.

Distribution: Martin Mountain, Maryland.

Stratigraphic range: Silurian, Tonoloway formation.

Repository: Holotype is in the collections of the U. S. National Museum.

EURYPTERUS REMIPES LACULATUS Kjellesvig-Waering, n. subsp.

Pl. 148, fig. 1

Eurypterus remipes CLARKE & RUEDEMANN, 1912, p. 172, pl. 6, fig. 6.

In their monograph, Clarke & Ruedemann (1912, p. 172, pl. 6, fig. 6) figured and described a specimen from Morganville, New York which exhibited characteristics that had not previously been noted on other specimens of *Eurypterus remipes remipes* DeKay. The differences are readily apparent, but are in the present writer's opinion due to being a distinctly different form from either *Eurypterus remipes remipes* Dekay or *Eurypterus remipes lacustris* Harlan. The excellent preservation and uncrushed nature of the prosoma reveal important diagnostic details which have led the writer to redescribe and name this form as *Eurypterus remipes laculatus.*

Prosoma nearly quadrilateral, rounded at the anterolateral angles; genal angles form a right angle; anterior margin parallel to base and lateral margins nearly parallel. Prosoma is highly arched; surrounded by a noticeable marginal rim. A low, wide glabellar ridge is present behind the eyes.

Eyes reniform, medium in size, located anterior to the center of the prosoma. A distinct, deep depression surrounds the visual area of the lateral eyes extending from the posterior part of the eyes, in a curve, to the anterior. Ocellar mound small, is located on a low ridge midway between the lateral eyes. Ocelli are unusually small.

The first tergite is a band 3.2 mm. in length.

No ornamentation is present on the prosoma or tergite.

Measurements of holotype:	
Prosoma:	
Length:	18.5 mm.
Width:	25.5 mm.
Width behind eyes:	24.5 mm.
Lateral eyes located on prosoma:	
From anterior margin:	6.1 mm.
From posterior margin:	7.8 mm.
From lateral margin:	5.8 mm.
Eye length:	3.9 mm.
Eye width:	2.5 mm.
Apart at front:	8.7 mm.
Apart at back:	10.1 mm.
Ocellar mound located on prosoma:	
From anterior margin:	7.8 mm.
From posterior margin:	8.5 mm.
From lateral margin:	12.0 mm.
Diameter of ocelli:	0.1 mm.

Horizon and locality: Silurian: Cobleskill dolomite, preserved in porous, coarsely crystalline dolomite at Morganville, Genesee County, New York (W. P. Leutze, personal communication, October 7, 1957).

Repository: New York State Museum.

Remarks.—The distinct depression surrounding the lateral eyes is similar in many

respects to that described for *Erieopterus microphthalmus eriensis* (Whitfield). Uncrushed specimens of *Eurypterus remipes remipes* DeKay do not reveal such a conspicuous feature. It should be noted that the preservation of this specimen is excellent and reveals such small details as the very small ocelli (0.1 mm. in diameter). Nevertheless, the conspicuous row of spines at the posterior of the prosoma and on the middle of mesosomatic tergites is not present as in *Eurypterus remipes remipes* and *E. remipes lacustris*.

The new form herein described differs from *Eurypterus remipes remipes* DeKay, *Eurypterus remipes lacustris* Harlan, *Eurypterus remipes quebecencis* Kjellesvig-Waering, *Eurypterus remipes flintstonensis* Swartz, and *Eurypterus remipes tetragonophthalmus* Fischer in the more quadrate form of the prosoma, the conspicuous depression surrounding the visual area of the eyes, the much smaller ocelli and ocellar mound, and the lack of thick spines at the base of the prosoma or central part of the mesosomatic tergites.

EURYPTERUS REMIPES LACUSTRIS Harlan
Pl. 146, fig. 1; text-figs. 17 and 27

Eurypterus lacustris HARLAN, 1834, p. 98, pl. 5; 1834a, p. 297; HIBBERT, 1836, p. XII; MILNE-EDWARDS, 1836, p. 422; FISCHER, 1839, p. 126; GEINITZ, 1856, p. 220; JORDAN & MEYER, 1856, p. 10; HALL, 1859, p. 407, pl. 81, figs. 1,2; pl. 81A, fig. 1; pl. 81B, figs. 1–5, pl. 83B, fig. 3; text-fig. 5; SALTER, 1859, p. 235; GROTE & PITT, 1875, p. 2; MILLER, 1877, p. 217; SCHMIDT, 1883, p. 62; HALL, 1884, p. 29; FRAIPONT, 1889, p. 57; MILLER, 1889, p. 548; WHITFIELD, 1893, p. 416; HOLM, 1898, p. 9; GRABAU, 1901, p. 229; CLARKE, 1909, p. 37; GRABAU & SHIMER, 1910, p. 408, fig. 1708; CLARKE & RUEDEMANN, 1912, p. 173–178, pls. 9–12; pl. 13, fig. 3; text-figs. 35,36; WOODWARD, 1913, p. 297; O'CONNELL, 1916, p. 40; DIENER, 1924, p. 17; GRABAU, 1928, p. 325; fig. 1169b; STØRMER, 1933, p. 40, pl. 11, figs. 5,6, text-fig. 17a; ——, 1933a, pl. 122; KINDLE, 1934, p. 44; KJELLESVIG-WAERING, 1934, p. 387; SHIMER & SHROCK, 1944, p. 707, pl. 229; KJELLESVIG-WAERING, 1951, p. 21; CASTER & KJELLESVIG-WAERING, 1956, p. 19; VAN OYEN, 1956, p. 54.

Eurypterus pachycheirus HALL, 1859, p. 412, pl. 82, figs. 1–3; GROTE & PITT, 1875, p. 20; MILLER, 1877, p. 217; HALL, 1884, p. 29; MILLER, 1889, p. 548; GRABAU, 1901, p. 230; CLARKE, 1903, p. 711; ——, 1910, p. 37.

Eurypterus lacustris var. *pachycheirus* CLARKE & RUEDEMANN, 1912, p. 179–180, pl. 12, fig. 3; pl. 19, fig. 1; WOODWARD, 1913, p. 298; O'CONNELL, 1916, p. 40; DIENER, 1924, p. 17.

Eurypterus lacustris var. *robustus* HALL, 1859, p. 410–411, pl. LXXXIV, fig. 1; MILLER, 1877, p. 217; HALL, 1884, p. 29; MILLER, 1889, p. 548; (=*Eurypterus lacustris*) CLARKE & RUEDEMANN, 1912, p. 178.

Eurypterus remipes PICTET, 1853, p. 29, pl. xlvi, fig. 14; BRONN & ROEMER, 1854, p. 666, pl. 9, fig. 1; LOGAN, 1863, p. 353–354, fig. 464.

Eurypterus robustus MEEK & WORTHEN, 1868, p. 19; SCHMIDT, 1883, p. 49; HOLM, 1898, p. 35; GRABAU, 1901, p. 229; CLARKE, 1909, p. 37; GRABAU & SHIMER, 1910, p. 408.

Non Eurypterus remipes lacustris Harlan

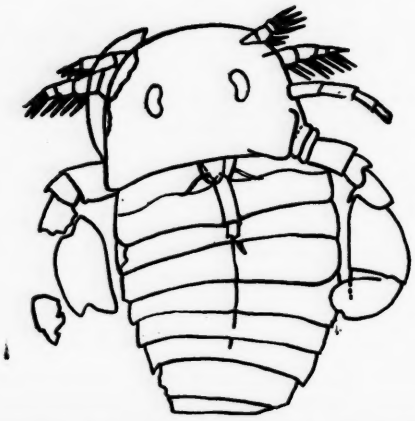
Eurypterus lacustris SALTER, 1859, p. 235 (=*Eurypterus remipes remipes* Dekay).

Eurypterus lacustris CLAYPOLE, 1890, p. 259 =*Onychopterella kokomoensis* (Miller and Gurley).

Eurypterus lacustris KINDLE, 1913, p. 288 =*Onychopterella kokomoensis* (Miller & Gurley).

This species is one of the best known and represents the most common element of the Bertie eurypterid assemblage of the Buffalo area. It has been well described, in particular by Hall (1859) and Clarke & Ruedemann (1912). Specimens found are consistently larger than those of *Eurypterus remipes remipes* DeKay, although individuals of the latter are occasionally found of nearly the same proportions. Like *Eurypterus remipes remipes* and *E. remipes tetragonophthalmus*, *E. remipes lacustris* Harlan represents one of the best known fossils in regard to morphological details. Little statistical data, however, have been documented. A number of the more interesting and better preserved specimens which the writer has studied are worthy of description.

A specimen (U. C. 28988) at the Walker Museum, University of Chicago, is remarkably preserved and adds to our knowledge of this well known form. This is a typical specimen, from the Williamsville limestone at Decewville, Ontario; it is nearly whole except for the anterior part of the prosoma and is preserved in an uncrushed and undistorted condition. The remarkable feature of this specimen is that it can be lifted off the matrix, revealing details and relationships of the dorsal and ventral sides. The underside reveals a well preserved metastoma, the anterior end of the male genitalia and the inside of the abdominal plates. The latter are overlapping, each overlaps approximately the anterior half of the succeeding plate, and each is divided by a definite



TEXT-FIG. 27—Outline drawing of ventral side of a specimen of *Eurypterus remipes lacustris* Harlan, from the Williamsville dolomite, Buffalo, New York. The dorsal, compound eyes are reflected through the integument; the ventral shield has been displaced forward; the male genital appendage with well preserved internal tubules is almost completely preserved; however, the rear of the metastoma partly covers the pentagonal pieces; the ventral sutures of the sternites are well shown and the vestige of a suture on the succeeding tergite is preserved. ×½.

suture at midsection. The last abdominal plate (no. 4) is only faintly sutured at the anterior; the sutures are more pronounced toward the anterior plates. Each suture is limbate on the interior of each plate; this would result in an indented line on the ventral or outside of the plate. The specimen in Text-fig. 27 retains the sutures of the abdominal plates but the succeeding sternite likewise retains a faint suture on the anterior midsection.

Several points of coincidence between dorsal and ventral structures are apparent (Text-fig. 17). The metastoma occupies a position from midsection of the lateral eyes to the anterior edge of the first tergite. The first tergite overlies the anterior edge of the operculum. The operculum extends from the anterior edge of the first tergite to the posterior edge of the second. The last abdominal plate covers three quarters of the dorsal part of the sixth tergite.

The specimen is approximately 25 cm. in length. The greatest depth of the entire body is present immediately behind the metastoma where it measures 6.5 mm. in thickness. The metastoma measures 21 mm. in length and 13 mm. in width. Other measurements of this interesting specimen are given in the table that follows.

Another well preserved and unusual specimen is illustrated on Pl. 146, fig. 1. This specimen is from the Williamsville limestone at Buffalo and reveals a well preserved, uncrushed but slightly distorted prosoma, attached first tergite, and a well preserved, complete operculum which has been displaced posteriorly from the prosoma. The operculum is preserved from the interior; scalelike ornamentation covers the anterior part and increases in density anteriorly. The male genitalia are particularly well preserved and reveal the internal tubular structure of the left side which has been turned over to the left. The paired internal tubular structures are well shown, in normal position on Text-fig. 27. Length of operculum 19.0 mm.; width at base is 69.0 mm. Length of genitalia (exclusive of pentagonal basal pieces): 28 mm.; greatest width: 6.5 mm. Other measurements are given in the tables on the next page.

Distribution: Western New York, particularly the Buffalo area and Ontario.

Stratigraphic range: All specimens that have been documented and figured in published reports or any that the writer has studied in various museums are from the Williamsville waterlime member of the Bertie formation (Silurian). The subspecies is by far the most common form encountered in the Williamsville eurypterid assemblage at Buffalo and adjacent areas. Willard P. Leutze, who has recently done considerable field work to unravel the confusion existing among the various members of the Bertie formation considers *Eurypterus remipes lacustris* as a Williamsville form (personal communication, May 28, 1957).

The specimens figured on Pl. 146, fig. 1, and Text-fig. 27 are from the Williamsville waterlime at Buffalo, New York, as well as specimen listed as no. 915, "U.S.N.M.," and "I.U." listed above. Specimen U.C. 28988 is from the Williamsville waterlime at Decewville, Ontario.

Depository: Specimens figured on Pl. 146, fig. 1, and on Text-fig. 27 are in the Geological Museum, University of Wisconsin. Specimen no. T.U. 26, is in the Geological

MEASUREMENTS OF SPECIMENS

Prosomal measurements:

Specimen Number:	Length:	Width at base:	Width behind eyes:	Length to width ratio:
Text-fig. 27	36.0 mm.	58.0 mm.		6.2:10
915	36.3 mm.	57.0 mm.	51.0 mm.	6.4:10
T.U. 26	40.5 mm.	62.7 mm.	55.1 mm.	6.5:10
U.S.N.M.	40.6 mm.	61.0 mm.	55.5 mm.	6.7:10
U.C.—28988	broken	61.4 mm.		
Pl. 146, fig. 1	41.0 mm.	66.0 mm.		6.2:10

The lateral eye measurements:

Specimen Number:	From anterior margin:	From posterior margin:	From lateral margin:	Apart at front:	Apart at back:	Length	Width:
Text-fig. 27	11.7 mm.	15.0 mm.	11.5 mm.	19.5 mm.		8.0 mm.	4.0 mm.
915	11.8 mm.	16.0 mm.	10.1 mm.	19.8 mm.	23.0 mm.	8.0 mm.	3.3 mm.
T. U. 26	13.0 mm.	18.5 mm.	11.5 mm.	21.0 mm.	23.4 mm.	8.3 mm.	4.2 mm.
U.S.N.M.						7.9 mm.	
U.C. 28988		19.7 mm.	14.3 mm. ±	24.0 mm.		7.8 mm.	4.2 mm.
Pl. 146, fig. 1	15.5 mm.	20.0 mm.	11.5 mm.	22.0 mm.		7.0 mm.	4.5 mm. ±

Ocellar mound located on prosoma:

Specimen Number:	From Anterior margin	From posterior margin:	From lateral margin:
915	17.0 mm.	18.6 mm.	23.5 mm.
T.U. 26	18.0 mm.	19.5 mm.	24.0 mm.

Opisthosomal measurements:

Length of tergites:

Specimen Number:	915	T.U. 26	U.C. 28988	I.U.
Tergite No. 1	6.3 mm.	8.0 mm.	10.2 mm.	
Tergite No. 2	8.5 mm.	8.2 mm.	10.2 mm.	5.0 mm.
Tergite No. 3	8.2 mm.	9.5 mm.	9.8 mm.	5.0 mm.
Tergite No. 4	8.5 mm.	9.2 mm.	10.0 mm.	5.5 mm.
Tergite No. 5	8.5 mm.	12.0 mm.	10.0 mm.	5.0 mm.
Tergite No. 6	8.5 mm.	12.0 mm.	10.0 mm.	5.0 mm.
Tergite No. 7	8.5 mm.		11.0 mm.	5.0 mm.
Tergite No. 8	9.0 mm.		11.6 mm.	6.0 mm.
Tergite No. 9	10.2 mm.		11.0 mm.	6.0 mm.
Tergite No. 10	13.2 mm.		12.6 mm.	8.0 mm.
Tergite No. 11	14.1 mm.		15.8 mm.	
Tergite No. 12	18.5 mm.		21.0 mm.	
Telson			63.0 mm.	

Width of tergites:

Specimen Number:	915	T.U. 26	U.C. 28988	I.U.
Tergite No. 1	57.6 mm.	63.5 mm.	64.7 mm.	
Tergite No. 2	61.0 mm.	65.1 mm.	67.0 mm.	29.0 mm.
Tergite No. 3	62.3 mm.	66.0 mm.	70.0 mm.	30.0 mm.
Tergite No. 4	61.7 mm.	64.0 mm.	66.8 mm.	27.0 mm.
Tergite No. 5	58.0 mm.	58.5 mm.	60.0 mm.	25.0 mm.
Tergite No. 6	51.7 mm.	51.5 mm.	52.6 mm.	21.0 mm.
Tergite No. 7	44.7 mm.		44.8 mm.	17.0 mm.
Tergite No. 8	36.4 mm.		37.4 mm.	16.0 mm.
Tergite No. 9	32.8 mm.		32.5 mm.	14.0 mm.
Tergite No. 10	28.6 mm.		28.5 mm.	11.0 mm.
Tergite No. 11	23.0 mm.		26.3 mm.	
Tergite No. 12	18.0 mm.		20.5 mm.	
Telson width at base	11.2 mm.		12.2 mm.	

Museum, Tulsa University; the specimen listed as U.S.N.M. is one collected by Julius Pohlman and is in the U. S, National Museum; the specimen listed as U.C. 28988 is from the collections of the Walker Museum, Chicago University; the specimen listed as I.U. was collected by Cornelia Cameron and is in the Geology Department, State University of Iowa; specimen 915 is in the Peabody Museum, Yale University.

Remarks.—Hall (1859, p. 412) named and described *Eurypterus pachycheirus* from the Williamsville waterlime at Buffalo, New York. He based his species on the greater width of the distal part of the swimming leg and on the more strongly developed sculpturing than that present in *E. lacustric* Harlan. Clarke & Ruedemann (1922, p. 180) stated in regard to the alleged differences of the swimming leg that numerous specimens of *E. lacustris* had equally broad swimming legs and, moreover, that the stronger development of the sculpturing was due to the preservational state. Surprisingly, however, the two authors, after revealing that both *E. lacustris* and *E. pachycheirus* were the same form, designated *pachycheirus* as a variety of *E. lacustris* rather than to its synonomy.

The differences cited by Hall have not been substantiated and, therefore, *E. pachycheirus* is herein included in the synonomy of *Eurypterus remipes lacustris* Harlan. The typical specimen of the latter figured on Text-fig. 27 has well developed, broad swimming legs not unlike Hall's originals. The writer agrees with Clarke & Ruedemann that Hall's *E. lacustris* var. *robustus* should be included as a synonym of *E. remipes lacustris* Harlan.

The differences between *Eurypterus remipes remipes* DeKay and *Eurypterus remipes lacustris* Harlan are minor and are considered by the writer to be of subspecific value. As stated above, *Eurypterus remipes remipes* is a Fiddlers Green form, whereas the latter is restricted to the Williamsville member. The two forms, therefore, appear to have stratigraphic value. The differentiation of the two should be based mainly on the differences in the prosoma and the genital appendage. The writer considers *E. remipes lacustris* to be a development from *E. remipes remipes;* the subspecific differences are therefore temporal rather than geographic as previously thought by most authors.

Although individual specimens of *E. remipes remipes* may approach *E. remipes lacustris* in size, there is no doubt that in the greater majority, the specimens found are all much smaller. The latter is considerably, and consistently, much larger. The main differences, morphologically, between the two forms are found in the broader prosoma of *E. remipes lacustris* as against the more quadrate form present in *E. remipes remipes.* The former has the antelateral angles more rounded and the lateral margins more convergent than the latter. In the list of measurements of the prosoma given above for *Eurypterus remipes lacustris,* five specimens, and the two measured by Clarke & Ruedemann (1912, p. 177), the length to width ratio varies from 6.2 to 7:10, or an average of 6.6:10 for a total of seven specimens. In contrast the range of the length to width ratio of *Eurypterus remipes remipes* in fourteen specimens measured in the above list and the specimens measured by Clarke & Ruedemann (1912, p. 170) varies from 6.7 to 8.0:10 or an average of 7.5:10 for a total of 17 specimens. Another important difference between the two subspecies is presence in the structure of the male medial appendage. *E. remipes lacustris* has far less flaring of the posterior parts of the joints than *E. remipes remipes.* Minor differences occur in the structure of the prosomal appendages, particularly the shape of the paddle.

EURYPTERUS REMIPES QUEBECENSIS
Kjellesvig-Waering, n. subsp.
(plate 146, figure 2)

Eurypterus remipes KINDLE, 1934, p. 44, fig. 1; NORTHROP, 1938, p. 246–247.

The holotype, and only known specimen, consists of a mold of a complete dorsal shield and attached first tergite, preserved in an uncrushed condition in sandstone.

The dorsal shield is broadly rounded on the anterior lateral margins. The lateral margins converge forward gradually; the base is nearly straight. A thick, steeply inclined marginal rim borders the shield. This thick rim, about 2.5 mm. in depth, gradually narrows backward toward the genal angles to less than half of the anterior width. The rim is a prominent feature of the dorsal shield. A centrally located narrow glabellar ridge occurs from slightly behind the eyes to nearly the base of the dorsal shield. The area directly in front and between the eyes is raised and dips steeply into the anterior rim. Near the base is a row of six prominent spinelike projections. These spines are thick; three occur on each side of the median line. No other ornamentation has been noted on the dorsal shield. The dorsal shield

measures 41.2 mm. in length and 61.0 mm. in width at the base, giving a proportional ratio of 6.8:10.

Lateral eyes prominent, located well in front of the middle of the dorsal shield, and rather close set. Each eye measures 7.5 mm. in length and 4.2 mm. in width. They are located 18.8 mm. apart, 14.3 mm. from the lateral margins, 13.1 mm. from the anterior margin and 21.0 mm. from the posterior margin. The ocelli are not apparent. The bandlike attached first tergite measures 7.2 mm. in length. No ornamentation is present.

Distribution: 1½ miles south of Port Daniel, Bay of Chaleur, Quebec, Canada.

Stratigraphic range: Silurian, Gascons formation.

Remarks.—The above description was made from a latex cast kindly sent to the writer by Dr. Walter A. Bell. This specimen was originally described by Kindle as *Eurypterus remipes* DeKay. Direct comparison with typical specimens of the latter form reveals considerable differences. In comparison with *Eurypterus remipes remipes* the main differences are apparent in the general outline of the dorsal shield and the position of the lateral eyes. The dorsal shield of *E. remipes quebecensis* is broadly rounded at the anterior lateral and anterior margins. In *E. remipes remipes* the anterior lateral margins and anterior margins are more angular, giving a subquadrate appearance. The lateral eyes of *E. remipes quebecensis* are located farther forward and are closer together than the eyes of *E. remipes remipes*. Another important difference in these two species is the row of six thick spinelike scales which occurs on the base of the dorsal shield of *E. remipes quebecensis*. *E. remipes remipes*, as far as the writer has been able to observe, has only four spines which apparently are not as prominent. The marginal rim of *E. remipes quebecensis* appears to be considerably more inclined and prominent than in *E. remipes remipes*, a condition, however, that may be due to preservation in sandstone as an uncrushed impression.

Eurypterus remipes quebecensis differs from *E. remipes lacustris* Harlan in having a dorsal shield which is more rounded at the antelateral margins and in having the lateral eyes more closely set, and proportionately more anteriorly located. As in *E. remipes remipes*, the basal row of spines in *E. remipes lacustris* is not as prominently developed as in *E. remipes quebecensis* (Pl. 146, figs. 1 and 2). The prosoma is proportionately wider than *E. remipes remipes* but not as wide as *E. remipes lacustris*.

The holotype is registered as No. 9145 in the collections of the Geological Survey of Canada.

EURYPTERUS REMIPES REMIPES DeKay

Pl. 143, figs. 1,2; pl. 144; pl. 145, fig. 3; text-figs. 15,18,19

Eurypterus remipes DEKAY, 1825, p. 375, pl. 29; DEMAREST, 1827, p. 311–313; DEKAY, 1828, p. 273; HARLAN, 1834, p. 96, pl. 5; BRONN, 1835, p. 109, fig. 1; MILNE-EDWARDS, 1836, p. 422; FISCHER, 1839, p. 125; CONRAD, 1841, p. 38; VANUXEM, 1842, p. 100, fig. 17; BURMEISTER, 1843, p. 62; ——, 1846, p. 54; REUSS, 1855, p. 83; JORDAN & MEYER, 1856, p. 10; BIGSBY, 1859, p. 314; SALTER, 1859, p. 235; HALL, 1859, p. 404, pl. 80, figs. 1–12; pl. 80A, figs. 1–5, pl. 83B, fig. 2, text-fig. 6; WOODWARD, 1864, p. 108; MEEK & WORTHEN, 1868, p. 19; 1868a, p. 546; MILLER, 1877, p. 218; HALL, 1878, p. 72; SCHMIDT, 1883, p. 30; CLAYPOLE, 1884, p. 238, text-fig. a; HALL, 1884, p. 29; WOODWARD, 1887, p. 483; PEACH, 1888, p. 442; FRAIPONT, 1889, p. 57; LESLEY, 1889, p. 236; MILLER, 1889, p. 548, fig. 1008; WHITFIELD, 1893, p. 416; MILLER, 1896, p. 90; LAURIE, 1898 (1899), p. 587; HOLM, 1899, p. 86; CLARKE, 1900, p. 676, fig. 1420–1421; ——, 1903, p. 711; ——, 1909, p. 133; GRABAU & SHIMER, 1910, p. 408, fig. 1709; CLARKE & RUEDEMANN, 1912, p. 161–173, pls. 2,3; pl. 4, figs. 1–4; pl. 5, pl. 6, figs. 1–5,7,8; pls. 7,8; text-figs. 33,34; CLARKE, 1913, p. 782, figs. 1505, 1508; WOODWARD, 1913, p. 297; O'CONNELL, 1916, p. 41; RUEDEMANN, 1916, p. 74; DIENER, 1924, p. 19; GRABAU, 1928, p. 148, fig. 934; STØRMER, 1933, p. 122; KJELLESVIG-WAERING, 1934, p. 387; STØRMER, 1934, p. 18; EHLERS, 1935, p. 293; TWENHOFEL & SHROCK, 1935, p. 468, fig. 172D,E; SHIMER & SHROCK, 1944, p. 707, pl. 299, figs. 1,2; KJELLESVIG-WAERING, 1948, p. 470; ——, 1948a, p. 4; ——, 1951, p. 20; STØRMER, 1955, p. 33; CASTER & KJELLESVIG-WAERING, 1956, p. 20.

Non Eurypterus remipes remipes DeKay

Eurypterus remipes ROEMER, 1848, pl. 27 (=*Eurypterus remipes tetragonophthalmus* (Fischer).

Eurypterus remipes KEYSERLING, 1853, p. 153, (=*Eurypterus remipes tetragonophthalmus* Fischer).

Eurypterus remipes PICTET, 1853, p. 29, pl. xlvi (=*Eurypterus remipes lacustris* Harlan).

Eurypterus remipes BRONN & ROEMER, 1854, pl. 9, fig. 1 (=*Eurypterus remipes lacustris* Harlan).

Eurypterus remipes EICHWALD, 1854, p. 100, pl. 1

(=*Eurypterus remipes tetragonophthalmus* Fischer).

Eurypterus remipes SCHRENK, 1954, p. 35, (=*Eurypterus remipes tetragonophthalmus* Fischer).

Eurypterus remipes MURCHISON, 1856, p. 23 (=*Eurypterus remipes tetragonophthalmus* Fischer).

Eurypterus remipes SALTER, 1856, p. 26 (=*Eurypterus remipes tetragonophthalmus* Fischer).

Eurypterus remipes SCHMIDT, 1858, p. 191 (=*Eurypterus remipes tetragonophthalmus* Fischer).

Eurypterus remipes NIESZKOWSKI, 1859, p. 299–344, pl. 1, II (=*Eurypterus remipes tetragonophthalmus* Fischer).

Eurypterus remipes SCHMIDT, 1859, p. 470 (=*Eurypterus remipes tetragonophthalmus* Fischer).

Eurypterus remipes LOGAN, 1863, p. 353–354, fig. 464 (=*Eurypterus remipes lacustris* Harland).

Eurypterus remipes ROEMER, 1876, pl. 18 (=*Eurypterus remipes tetragonophthalmus* Fischer).

Eurypterus remipes GERSTACKER, 1879, p. 35, figs. 13–16 (=*Eurypterus remipes tetragonophthalmus* Fischer).

Eurypterus remipes? LESLEY, 1889, p. 236 (=*Adelophthalmus pennsylvanicus* (Hall)).

Eurypterus remipes? MILLER, 1889, p. 571 (=*Proscorpius osborni* Whitfield).

Eurypterus remipes GRABAU, 1901, p. 229, pl. 18 (=*Eurypterus remipes lacustris* Harlan).

Eurypterus remipes CLARKE & RUEDEMANN, 1912, p. 172, pl. 6, fig. 6 (=*Eurypterus remipes laculatus* Kjellesvig-Waering).

Eurypterus remipes KINDLE, 1934, fig. 2 (top) (=*Eurypterus remipes lacustris* Harlan).

Eurypterus remipes KINDLE, 1934, p. 44, fig. 1 (=*Eurypterus remipes quebecensis* Kjellesvig-Waering).

Eurypterus remipes NORTHROP, 1938, p. 246–247 (=*Eurypterus remipes quebecensis* Kjellesvig-Waering).

Eurypterus remipes LEUTZE, 1936, p. 197 (=*Eurypterus remipes* ssp. nov.).

Excellent descriptions have been given of this form by Hall (1859, p. 404) and in particular by Clarke & Ruedemann (1912, p. 161). Although *Eurypterus remipes remipes* has been found in great numbers, most of the specimens, at least those preserved on the ventral side, have proven to be males. Little is known of the female appendage.

Pl. 143, Fig. 1, shows this species in dorsal aspect, whereas the venter, a male, is illustrated in Plate 144. The ventral shield or doublure is very well revealed in the specimen illustrated on Pl. 145, Fig. 3. It consists of two bandlike plates joined at midsection by a suture. A poorly developed rostral area is present. A narrow marginal rim surrounds the shield; the central suture does not penetrate the rim. It is along the inner edge of the marginal rim that moulting occurs. The specimen on Pl. 145, Fig. 3, shows a distinct split along this zone of weakness (Text-fig. 18 and 19).

This same specimen reveals that the median suture joining each half of the abdominal plates is very weak, and like the marginal suture of the doublure probably opens during the ecdysis. The sutures open only on the first three abdominal plates; the posterior plate has the suture present only in the anterior part.

Although this species is one of the best known fossils, little has been published concerning measurements which might enable other workers to make comparisons with other forms. The table on page 1133 represents some of these data but considerably more is needed.

Distribution: Central New York, particularly Herkimer, Oneida, and Cayuga Counties (see remarks).

Stratigraphic range: Fiddlers Green dolomite of the Bertie formation (Silurian).

Repository: Specimens no. 9003, A, B, C, D, E, F, and 9009, are from the Fiddlers Green member of the Bertie formation at Jerusalem Hill, Litchfield, Herkimer County, New York and are in the collections of the Peabody Museum, Yale University. Specimen listed as "U.S.N.M." is from the Fiddlers Green member of the Bertie formation at Cranes Corners, Herkimer County, New York, and is in the collections of the U. S. National Museum. Specimen no. 211/363 is from the Fiddlers Green member at Passage Gulf, Herkimer County, New York, and is in the collection of Willard P. Leutze.

Remarks.—All specimens which have been properly documented by illustration in the literature come from the Fiddlers Green member of the Bertie formation. Also, all specimens that the writer has studied in various museums or that he has seen are from the Fiddlers Green member. Clarke & Ruedemann report this form possibly from the Buffalo area, but do not document their determination. Leutze (personal communication, May, 1957) states that he has not encountered *E. remipes remipes* above the Fiddlers Green. He, however, reported it in the *Actinopteria* zone of the Syracuse formation (1956, p. 1967). Other collections of better preserved specimens have led Leutze to consider the Syracuse form as being different from typical *E. remipes remipes* (per-

Measurements of Specimens

Prosomal measurements:

Specimen Number:	Length:	Width at base:	Width behind eyes:	Ratio:
9003-F	7.8 mm.	9.7 mm.	9.5 mm.	8.0:10
9003-D no. 2	8.5 mm.	11.3 mm.		7.5:10
9003-E	12.0 mm.	16.0 mm.	14.1 mm.	7.5:10
9003-D no. 1	12.5 mm.	16.3 mm.		7.7:10
U.S.N.M. (unlisted)	16.5 mm.	23.0 mm.	23.0 mm.	7.2:10
47039	17.2 mm.	22.6 mm.	20.6 mm.	7.6:10
47040	20.5 mm.	26.6 mm.	25.0 mm.	7.7:10
211/363	21.3 mm.	27.9 mm.	26.8 mm.	7.6:10
9009	22.0 mm.	27.5 mm.	27.0 mm.	8.0:10
47041	26.0 mm.	33.0 mm. (est.)	32.0 mm.	7.9:10
47038	31.7 mm.	42.5 mm.	41.0 mm.	7.5:10
9003-C	35.5 mm.	53.0 mm.	47.9 mm.	6.7:10
9003-B	44.5 mm. ±	58.0 mm. ±		7.7:10
9003-A	46.5 mm.	62.0 mm.	59.5 mm.	7.0:10

Lateral eyes:

Specimen Number:	Length:	Width:	From anterior margin:	From posterior margin:	From lateral margin:	Apart at front:	Apart at back:
9003-F	2.8 mm.	1.1 mm.	1.8 mm.	2.6 mm.	2.0 mm.	3.0 mm.	3.4 mm.
9003-D no. 2	3.1 mm.	1.4 mm.	1.7 mm.	3.5 mm.	1.5 mm.	3.2 mm.	6.1 mm.
9003-E	4.0 mm.	2.1 mm.	3.6 mm.	4.5 mm.	2.0 mm.	6.0 mm.	
9003-D no. 1	3.5 mm.	1.7 mm.					
47039	5.2 mm.	3.0 mm.				6.7 mm.	8.3 mm.
47040	5.8 mm.	2.1 mm.					
211/363	5.1 mm.	3.9 mm.	6.0 mm.	9.5 mm.	4.8 mm.	9.8 mm.	12.0 mm.
9009	5.4 mm.	3.1 mm.	7.5 mm.	8.6 mm.	4.3 mm.	8.6 mm.	10.4 mm.
9003-C	8.2 mm.	3.7 mm.	11.3 mm.	16.4 mm.	11.0 mm.	20.0 mm.	
9003-A	9.5 mm.	4.0 mm.	14.8 mm.	20.4 mm.	13.5 mm.	24.0 mm.	

Opisthosomal measurements:

Length of tergites:

Specimen Number:	9003-F	9003-E	9003-C	9003-A
Tergite No. 1	1.4 mm.	2.3 mm.	8.1 mm.	9.5 mm.
Tergite No. 2	1.4 mm.	2.6 mm.	8.1 mm.	9.5 mm.
Tergite No. 3	1.4 mm.	2.6 mm.	8.1 mm.	9.5 mm.
Tergite No. 4	1.6 mm.	2.7 mm.	9.0 mm.	8.0 mm.
Tergite No. 5	1.5 mm.	2.7 mm.	10.0 mm.	9.0 mm.
Tergite No. 6	1.3 mm.	2.1 mm.	10.3 mm.	7.5 mm.
Tergite No. 7	1.3 mm.	2.0 mm.	10.3 mm.	7.0 mm.
Tergite No. 8	1.5 mm.	2.2 mm.	11.1 mm.	8.0 mm.
Tergite No. 9	1.6 mm.	3.3 mm.	12.1 mm.	9.5 mm.
Tergite No. 10	2.5 mm.	4.1 mm.	12.5 mm.	10.0 mm.
Tergite No. 11	2.5 mm.	5.0 mm.	15.0 mm.	16.2 mm.
Tergite No. 12	3.6 mm.	6.0 mm.	18.6 mm.	21.5 mm.
Telson	11.2 mm.	18.5 mm.	absent	absent

Width of tergites at posterior:

Specimen Number:	9003-F	9003-E	9003-C	9003-A
Tergite No. 1	9.9 mm.	16.0 mm. ±	55.5 mm.	71.8 mm.
Tergite No. 2	10.0 mm.	17.0 mm.	59.0 mm.	75.5 mm.
Tergite No. 3	10.2 mm.	18.6 mm.	61.5 mm.	76.0 mm.
Tergite No. 4	10.2 mm.	17.7 mm.	58.0 mm.	73.0 mm.
Tergite No. 5	9.6 mm.	16.0 mm.	54.5 mm.	70.0 mm.
Tergite No. 6	8.4 mm.	15.2 mm.	48.5 mm.	63.5 mm.
Tergite No. 7	7.5 mm.	12.4 mm.	39.5 mm.	52.2 mm.
Tergite No. 8	6.0 mm.	10.5 mm.	33.8 mm.	43.5 mm.
Tergite No. 9	5.0 mm.	9.0 mm.	28.5 mm.	38.5 mm.
Tergite No. 10	4.5 mm.	7.5 mm.	25.0 mm.	33.3 mm.
Tergite No. 11	4.1 mm.	6.6 mm.	21.0 mm.	27.6 mm.
Tergite No. 12	3.1 mm.	5.5 mm.	12.2 mm.	21.5 mm.

sonal communication, October, 1957). The present writer has seen only a rubber cast of a specimen (18/11) in which the prosoma is half covered and reveals a rather quadrate prosoma with a more thickened prosomal rim than that present in typical specimens of *E. remipes remipes*. It is likely that the Syracuse form is a subspecies of *E. remipes*.

The main differences between *Eurypterus remipes remipes* and *Eurypterus remipes lacustris* lie mainly in the form of the prosoma and in the shape of the genital appendage. It is important therefore in differentiating both forms that the identification be based on the relative width of the prosoma or on the male genitalia. In *E. remipes remipes* the male median appendage reveals distinct flaring at the end of the first and second joints. In the corresponding organ of *E. remipes lacustris*, the flaring of the joints is not present. In the older *Eurypterus pittsfordensis*, the flaring of these joints reaches an extreme. As indicated by the male appendage, as other structures, it is likely that *Eurypterus pittsfordensis* is ancestral to *Eurypterus remipes remipes*, and that *Eurypterus remipes lacustris* developed directly from *E. remipes remipes*. Stratigraphic evidence supports this development. *E. pittsfordensis* is a well known form from the Pittsford shale at the base of the Vernon formation, whereas *E. remipes remipes* is a Fiddlers Green form of the Bertie formation and *E. remipes lacustris* is a definite Williamsville form. The obvious gradation of the male appendage in these eurypterids suggests that the Williamsville assemblage of eurypterids is younger than the Fiddlers Green forms. This is the opinion also of Willard P. Leutze on the basis of field investigation (personal communication, May, 1957).

EURYPTERUS REMIPES SWARTZI
Kjellesvig-Waering, n. subsp.
Pl. 143, fig. 3; pl. 145, fig. 2;
text-figs. 12–14

Dolichopterus cumberlandicus (*partim*) SWARTZ, 1923, pl. LXVII, fig. 3.

Swartz (1923, p. 717–718) described several specimens from the Wills Creek formation at Riverside, West Virginia which he included under his new species *Dolichopterus cumberlandicus*. The group of prosomal appendages and operculum figured on plate LXVII, Fig. 3 clearly is an *Eurypterus*, not greatly unlike *E. remipes* DeKay. Minor differences in the walking legs, and particularly the swimming legs, indicate that this form should be redescribed as a subspecies of *E. remipes*. The writer proposes to name this form in honor of Charles K. Swartz.

The specimen herein figured on Pl. 145, Fig. 2, and Text-figs. 12,13, and 14, comprises a mass of integument which include parts of the first, second and third walking legs, nearly the entire swimming leg, and a poorly preserved operculum.

The walking legs are not unlike *Eurypte-*

EXPLANATION OF PLATE 145

FIG. *1*—Holotype of *Erieopterus hypsophthalmus* Kjellesvig-Waering, n. sp. from the Put-in-Bay dolomite of the Bass Islands formation at Beach Point, Put-in-Bay Island, Ohio, ×1.5. (19572, Geological Museum, Ohio State University).

2—Holotype of *Eurypterus remipes swartzi* Kjellesvig-Waering, n. ssp., from the Silurian, Wills Creek shale, at Riverside, West Virginia, ×1. (Formerly at Johns Hopkins University, now in U. S. National Museum.)

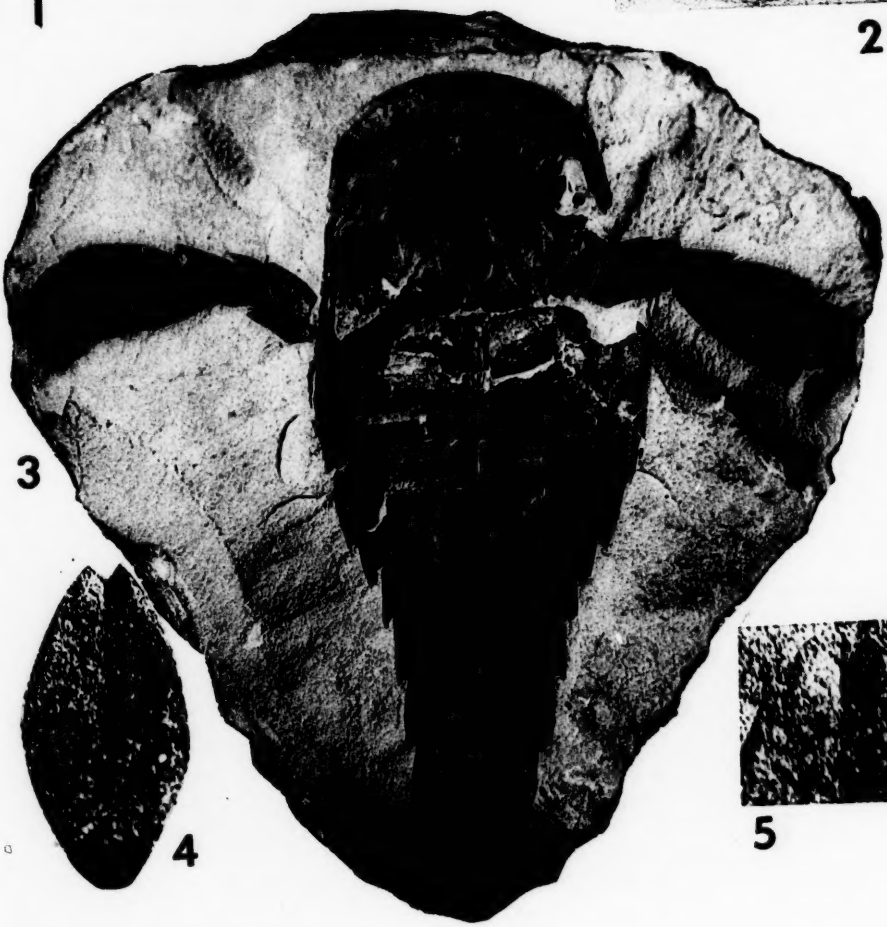
3—An unusually well preserved specimen of *Eurypterus remipes remipes* DeKay from the Fiddlers Green dolomite at Jerusalem Hill, Herkimer County, New York. The dorsal side has been stripped off revealing the inside of the venter. This is a male, retains the ventral shield (text-figs. 18,19) which shows a distinct split along the inner edge of the marginal rim, and further reveals opening of the sutures along the axis of the abdominal plates, a condition which probably occurred during ecdysis, ×$\frac{3}{4}$. (From the Jewitt Collection, no. 9003 in the Peabody Museum of Natural History, Yale University.)

4—The metastoma of *Eurypterus pittsfordensis* Sarle from the Pittsford shale at Pittsford, New York, seen from the inside. The central ridge (a depression from the outside) probably represents the vestige of a suture. This is the same specimen as illustrated in plate 148, fig. 7. ×4.

5—Same specimen as figure *4* further enlarged to show denticles along the notch of the metastoma, ×8.

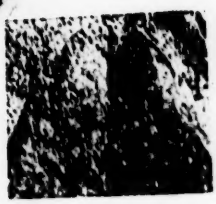
1

2



3

4



5

1

2

rus remipes remipes DeKay and *E. remipes lacustris* Harlan except that in the third walking leg, the terminal joint, a very thick spine, is much larger and thicker than in the New York forms. Another apparent difference is the much more slender paddle of *E. remipes swartzi* in comparison to the above mentioned forms. The triangular lobe of the sixth joint is much longer and considerably more pronounced than *E. remipes remipes* (Text-figs. 14 and 15 for comparison) or *E. remipes lacustris.*

The sixth joint of the swimming leg of *E. remipes swartzi* measures 17.2 mm. in length and 9.2 mm. in greatest width; the width to length ratio is therefore 5.3:10 as against an average of 6:10 in *Eurypterus remipes remipes.* The paddle, likewise, is much more slender in *E. remipes swartzi,* where it measures 6 mm. in greatest width and 11.5 mm. in length; the length-width ratio is therefore 5.2:10 whereas in *E. remipes remipes* the ratio is 6.1:10.

The operculum is too poorly preserved to warrant anything but casual comment. The specimen is a male; the internal part of the genitalia is preserved which shows that it barely extends to the posterior edge of the operculum and not past the operculum as in *E. remipes remipes* or *E. remipes lacustris.*

The differences cited for the proposed new subspecies are not great but sufficient to distinguish this from the New York forms.

Horizon and locality: Silurian, Wills Creek formation, at Riverside, West Virginia.

Repository: U. S. National Museum.

EURYPTERUS REMIPES TETRAGONOPHTHALMUS Fischer

Eurypterus tetragonophthalmus Fischer, 1839, p. 127–128, pl. VII, fig. 1; MURCHISON, (1855), 1856, p. 23; GEINITZ, 1856, p. 220; JORDAN & MEYER, 1856, p. 10; SALTER, 1856, p. 26.

Eurypterus remipes KEYSERLING, 1853, p. 153; EICHWALD, 1854, p. 49,100; SCHRENK, 1854, p. 35; MURCHISON, 1856, p. 23; SALTER, 1856, p. 26; SCHMIDT, 1858, p. 191; NIESZKOWSKI, 1859, p. 299–344, pl. 1, II; SCHMIDT, 1859, p. 470; RÖMER, 1878, pl. 18, fig. 4; GERSTÄCKER, 1879, pl. 35, figs. 13–16.

Eurypterus fischeri EICHWALD, 1857, p. 336; ——, 1860, p. 1355; SCHMIDT, 1876, p. 13; ——, 1883, p. 50–63; pls. II;III;IIIa, figs. 1–14; LAURIE, 1893, p. 125; ——, 1895, p. 158; ——, 1895a, p. 517; HOLM, 1896, p. 369–372; ——, 1898, p. 1–53, pls. I–III, pl. IV, figs. 1–22, 26; pls. V–VIII, pl. IX, figs. 1–9; SEMPER, 1898, p. 86; HOLM, 1899, p. 83–127, pls. I–IV, text-figs. 1–4; SARLE, 1903, p. 1087; SEEMAN, 1906, p. 54; CLARKE & RUEDEMANN, 1912, p. 14, etc.; text-figs. 3,12–15,19,22,32; CLARKE, 1913, p. 780, fig. 1506; WOODWARD, 1913, p. 294–295; BARBOUR, 1914, p. 195; O'CONNELL, 1916, p. 39; RUEDEMANN, 1919, p. 213; VERSLUYS, 1923, p. 312, fig. 12; DIENER, 1924, p. 16; FREBOLD, 1926; NEAVERSON, 1928, p. 91, fig. 15; VĂSCĂUTANU, 1932, p. 615, pl. VII, fig. 2; STØRMER, 1933a, p. 19, fig. 17b, fig. 26h; ——, 1934, p. 19; ——, 1934a, p. 8; TOBIEN, 1937, p. 254; STØRMER, 1938, p. 69–70, fig. 1; MOORE, 1941, p. 65; STØRMER, 1944, p. 43, fig. 8, fig. 9 (8–16,18,25), fig. 10 (5); KJELLESVIG-WAERING, 1948, p. 466; ——, 1951, p. 21; STØRMER, 1951, p. 419, fig. 2c; WATERLOT, 1953, p. 532, figs. 8–14; STØRMER, 1955, p. 34, figs. 17,18,19 (3a–c,e,f),20 (1); BROOKS, 1957, p. 906; RAW, 1957, p. 164, text-figs. 7B,8,A, B,C,D.

Eurypterus fischeri Holm: VAN OYEN, 1956, fig. 21a.

Eurypterus fisheri var. *rectangularis* SCHMIDT, 1883, p. 62–63, pl. 111a, fig. 15; O'CONNELL, 1916, p. 39; DIENER, 1924, p. 16.

Non Eurypterus remipes tetragonophthalmus Fischer

Eurypterus tetragonophthalmus MILLER, 1877, p. 218 (=probably *E. remipes remipes* DeKay).

Eurypterus fischeri SCHMIDT, 1883, pl. 6, fig. 7 (=*Dolichopterus*? sp.).

Eurypterus tetragonophthalmus HALL, 1884, p. 29 (=probably *E. remipes remipes* DeKay).

Eurypterus tetragonophthalmus MILLER, 1889, p. 549 (=probably *E. remipes remipes* DeKay).

The species *Eurypterus tetragonophthalmus* was properly described and figured by G. Fischer de Waldheim (1839, p. 127–128,

---

EXPLANATION OF PLATE 146

FIG. *1*—Unusually well preserved prosoma with attached first tergite and slightly displaced operculum (male), seen from the inside. *Eurypterus remipes lacustris* Harlan, from the Williamsville dolomite at Buffalo, New York, ×1.2 (Geological Museum, University of Wisconsin Collection).

2—Holotype of *Eurypterus remipes quebecensis* Kjellesvig-Waering, n. ssp., Silurian, Gascons formation, 1½ miles south of Port Daniel, Bay of Chaleur, Quebec, Canada (From Kindle, 1934, fig. 1). ×1. (Geological Survey of Canada, no. 9145.)

pl. VII, fig. 1) on the basis of a nearly complete individual from the Upper Silurian at Zwilewcy on the Smotriz, Podolia. Unfortunately, Fischer erroneously thought that the eyes were tetragonal in outline, a condition undoubtedly due to preservation. In 1852, Alexander Schrenk (reported in 1854) discovered the eurypterid fauna at Oesel (Saaremaa) and identified the common eurypterid of these beds as the North American species, *Eurypterus remipes* DeKay. In 1853, Eichwald, apparently unaware of Schrenk's previous discovery, announced the presence of eurypterids at the village of Wita in Oesel, and also misidentified the same eurypterid as *Eurypterus remipes* DeKay (Eichwald 1854, p. 49). Several authors, more or less during the period of 1852 to 1879, referred to the Oesel form as *E. remipes*. In 1857, Eichwald noted that the Oesel form was identical to Fischer's Podolian *E. tetragonophthalmus*, but because Fischer had incorrectly interpreted the lateral eyes as being tetragonal in outline, he renamed the species *Eurypterus fischeri*. Schmidt (1876, p. 14–15) further identified *E. tetragonophthalmus* with the Oesel *E. fischeri*. As such, the name *E. fischeri* became firmly established in the literature, and almost without exception, all authors used this name. It is a name that, mainly because of the great work by Holm, is as well known as that of any eurypterid. It is, however, unfortunate that the specific name *Eurypterus fischeri* Eichwald (1857) is clearly superceded in priority by the name *Eurypterus tetragonophthalmus* Fischer (1839), and that the latter is therefore the correct name for the species despite the erroneous connotation of the name.

There seems little question that both *Eurypterus remipes* and *Eurypterus tetragonophthalmus* are closely related, and differences between them are minor and probably of geographic or temporal character. Schmidt (1883, p. 62) noted the minor difference between the two and was the first to state that these differences were of geographic value. The present writer agrees with this interpretation, and considers *E. tetragonophthalmus* to be a subspecies of *E. remipes* DeKay. The subspecific differences are discussed below.

Few statistical data have been presented in the literature. The following represents some prosomal measurements taken from specimens mainly collected by Schmidt and now in American museums:

MEASUREMENTS OF SPECIMENS

Specimen Number:	Length:	Width at base:	Width behind eyes:	Ratio length to width:
Lot 60654	7.2 mm.	10.5 mm.	10.0 mm.	6.9:10
Lot 63358	8.0 mm.	12.2 mm.	10.6 mm.	6.6:10
Lot 60654	8.8 mm.	12.5 mm.	12.0 mm.	7.0:10
U.S.N.M.	11.0 mm.	16.0 mm.	14.5 mm.	6.9:10
Lot 60654	11.0 mm.	16.5 mm.	15.0 mm.	6.7:10
Lot 63357	13.4 mm.	21.1 mm.	19.0 mm.	6.4:10
Lot 61521	14.0 mm.	20.1 mm.	18.5 mm.	7.0:10
9002-C	14.6 mm.	19.6 mm.	18.5 mm.	7.5:10
9002-B	16.1 mm.	22.9 mm.	22.0 mm.	7.0:10
Lot 63357	16.6 mm.	22.0 mm.	20.3 mm.	7.5:10
Lot 60654	18.2 mm.	26.5 mm.	24.6 mm.	7.0:10
U.S.N.M.	18.7 mm.	25.7 mm.	24.5 mm.	7.3:10
9002-A	20.0 mm.	30.2 mm.	27.6 mm.	6.6:10
U.S.N.M.	21.1 mm.	29.2 mm.	27.6 mm.	7.2:10
Lot 60654	21.8 mm.	31.4 mm.	30.1 mm.	6.9:10
U.S.N.M.	23.5 mm.	31.3 mm.	30.5 mm.	7.5:10
Lot 63357	28.0 mm.	39.0 mm.	37.0 mm.	7.2:10

Distribution: Podolia (Schmidt, 1876), Romania (Văscăutanu 1932) Oesel (Saaremaa) Schmidt, Holm, and others); Gotland (Lindstrom, 1885), and Norway (Størmer, 1938).

Stratigraphic range: Upper Silurian, Zone

K, (Oesel); Lower Ludlow (Gotland); Ludlow Zone 9d (Ringerike, Norway), Hotin beds (Romania).

Repository: The specimens listed as Lots 60654, 61521, 63357, 63358 and "U.S.N.M." are in the collections of the U. S. National Museum. No. 9002-A is in the Peabody Museum, Yale University.

Remarks.—Schmidt (1883, p. 62) and Clarke & Ruedemann (1912, p. 171) have listed the differences between *E. remipes remipes* and *E. remipes tetragonophthalmus*, which in part are given below.

In comparison with *Eurypterus remipes remipes* DeKay, it is apparent that both have characteristics in common and that the differences between the two are minor but nevertheless definite. The prosoma of each, as noted in the measurements of numerous specimens, have the same length to width proportions. The lateral eyes of *E. remipes tetragonophthalmus* are however larger, in specimens of approximately the same size, than those present in *E. remipes remipes*. The ornamentational pattern on the prosoma of each is also different. An obvious difference is present in the paddles of the swimming legs. *E. remipes remipes* has a paddle in which the seventh joint is smaller than the sixth joint, a condition that is reversed in *E. remipes tetragonophthalmus*. Another difference in the prosomal appendages is present in the relative length of the spines in the walking legs. The anterior spines in *E. remipes remipes* are longer and do not differ as greatly in relation to the posterior spines as they do in *E. remipes tetragonophthalmus*. The pretelson of *E. remipes remipes* has not the development of epimeral spurs that is present in *E. remipes tetragonophthalmus*. Clarke & Ruedemann (1912, p. 171) also show that the ornamentation of the postabdomen differs. *E. remipes remipes* reveals rows of thick scales in single file, whereas *E. remipes tetragonophthalmus* retains longitudinal rows. Briefly, the main differences however are found in the relative size of the lateral eyes of the prosoma and in the prosomal appendages. *E. remipes tetragonophthalmus* is closer to *E. remipes remipes* than to any other North American subspecies. Therefore, the differences given for these subspecies in comparison to *E. remipes remipes* will also serve to distinguish the Oesel form.

EURYPTERUS (?) sp.

A small specimen, comprising part and counterpart, of an eurypterid from a hitherto unreported locality is listed here in the hope that attention may be directed and further specimens may be found from this interesting occurrence. The specimen is poorly preserved in dolomite but is important because the locality is new and separated from other eurypterid occurrences. It appears that part of the last four mesosomatic and anterior two metasomatic tergites are present. The dorsal surface is too indistinct to reveal much of the ornamentation; however, on the posterior part of the tergites is a row of large indistinct plicae, or bosses, at least four in number. A small part of the operculum occurs on the counterpart and reveals a single row of wide, small, pointed scales along the transverse suture. The ornamentation suggests *Eurypterus*. Overall length probably did not exceed three inches.

Horizon and locality: Silurian, Greenfield dolomite at Rucker Quarry, Greenfield, Ohio.

Depository: Registered as no. 18511 in the Geological Museum, Ohio State University.

ONYCHOPTERELLA KOKOMOENSIS (Miller & Gurley)

Eurypterus kokomoensis MILLER & GURLEY, 1896, p. 90, pl. 5, fig. 1

Eurypterus (Onychopterus) kokomoensis CLARKE & RUEDEMANN, 1912, p. 212–216; RAW, 1957, p. 164.

Onychopterus kokomoensis KJELLESVIG-WAERING, 1948, p. 472.

Onychopterella kokomoensis STØRMER, 1951, p. 421; ——, 1935, p. 34.

Eurypterus lacustris CLAYPOLE, 1890, p. 259; KINDLE, 1913, p. 288.

Eurypterus ranilarva CLARKE & RUEDEMANN, 1912, p. 208–211, pl. 17, fig. 7, pl. 18, figs. 1,2.

The genotype of the genus *Onychopterella* is the species most commonly found in the Kokomo eurypterid fauna; however, specimens are comparatively rare in museums. The species reveals distinct dolichopteroid or stylonuroid characteristics in the presence of the slender walking legs and unusual narrowness of the swimming legs, a condi-

tion which probably is of phylogenetic importance. The species *Eurypterus ranilarva* Clarke & Ruedemann (1912, p. 208) is considered by Kjellesvig-Waering (1948, p. 465–466) as a synonym of *Onychopterella kokomoensis* (Miller & Gurley).

Distribution: Known only from Kokomo, Indiana.

Stratigraphic range: Silurian: Kokomo limestone.

ONYCHOPTERELLA PUMILUS (Savage)

Eurypterus pumilus SAVAGE, 1915, p. 17, fig. 8.
Onychopterus pumilus KJELLESVIG-WAERING, 1948, p. 472.

The species is based on a nearly complete specimen exhibiting the ventral side, and retains part of the original coloration. No other specimens have been found since Savage's description. The holotype was borrowed by the writer, from which the following notes were made:

The specimen is preserved in fine grained calcareous sandstone with small pebbles. The color of the integument is bright brown, much like that noted in the Kokomo and Oesel eurypterids. The ornamentation comprises pointed scales. The metastoma is preserved only in part. The base is rounded, and the anterior is lacking. Greatest width of the metastoma is slightly anterior to the center.

The dorsal structures are reflected through the ventral side, enabling accurate measurements. These are as follows:

Dorsal shield:	
Length:	9.3 mm.
Width behind eyes:	11.5 mm.
Width at base:	13.5 mm.

The lateral eyes are 5.0 mm. apart; are located on the prosoma:

From anterior margin:	2.3 mm.
From lateral margin:	2.3 mm.
From base:	5.6±mm.
Length of lateral eye:	2.5 mm.
Width of lateral eye:	1.1 mm.

The overall length of holotype from the anterior margin of the carapace to the end of the telson is 39.0 mm., with the telson measuring 7.5 mm. in length and 3.5 mm. in greatest width at the base. The walking legs are very narrow, without spines, and the swimming leg is narrow and very long.

Stratigraphic range: Lower Silurian: in the lower part of the Essex (Edgewood) limestone.

Distribution: near Essex, Kankakee County, Illinois.

Repository: University of Illinois Geological Department.

Remarks.—The wide marginal rim, long narrow undifferentiated walking legs devoid of spines, the long narrow swimming legs, lack of constriction of the metasoma and the crescentic to pointed scales clearly designate this form as an *Onychopterella*. In comparison with *Onychopterella kokomoensis* (Miller & Gurley) it differs in having proportionally slimmer prosomal appendages, the tapering nature of the mesosoma, the pretelson, which lacks epimeral prolongations and the telson which is spikelike, rather than having a slight broadening at the posterior half. The position of the lateral eyes on *O. pumilus* is considerably more forward than in *O. kokomoensis*, a condition which may be due to the possible immaturity of the former.

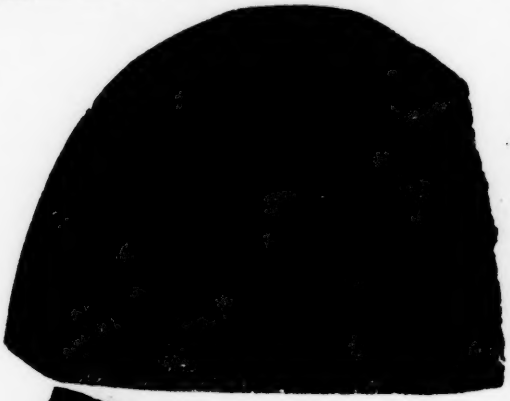
EXPLANATION OF PLATE 147

FIG. *1*—Carapace of *Erieopterus microphthalmus microphthalmus* (Hall) in Manlius limestone, near Olney limestone and Elmwood A contact, on talus slope on the north side of Split Rock Quarry, Syracuse, New York, ×1.4 (Geological Museum, Syracuse University).

2—Fragment of carapace of same species showing fine, pustular ornamentation. This is part of the specimen illustrated in figure *3* of this plate, ×3.

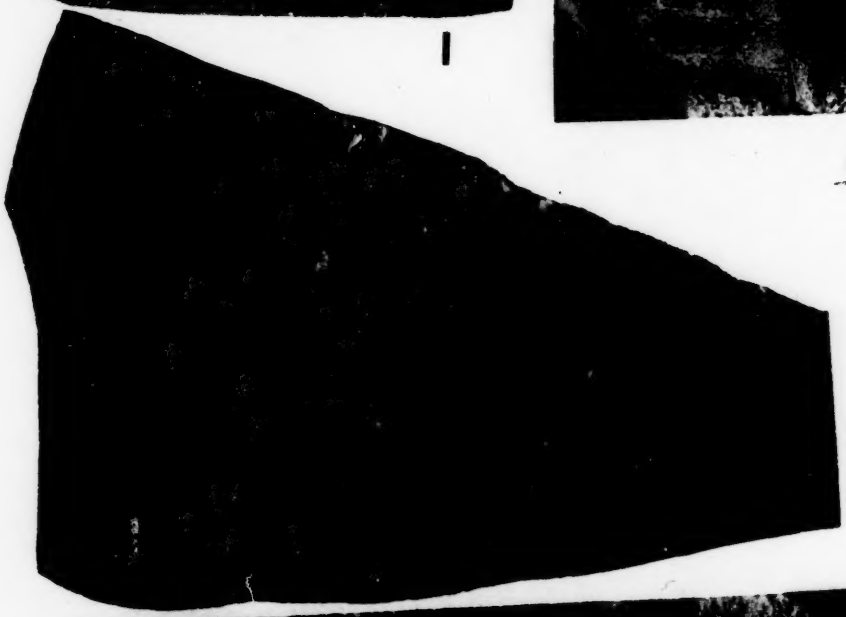
3—The largest specimen known of *Erieopterus microphthalmus microphthalmus* (Hall) from the same locality and horizon as figure *1*, ×1.2. Arrows indicate specimens of the brachiopod *Crispella vanuxemi* (Hall) commonly found on the same horizon as this particular eurypterid (Geological Museum, Syracuse University).

4—Smallest known specimen of *Erieopterus microphthalmus eriensis* (Whitfield) retaining the carapace and third walking leg and the mesosoma. This specimen is from the Put-in-Bay dolomite of the Bass Island formation at South Bass Island, Ohio, ×2.8 (no. 19614 in the Geological Museum, Ohio State University).



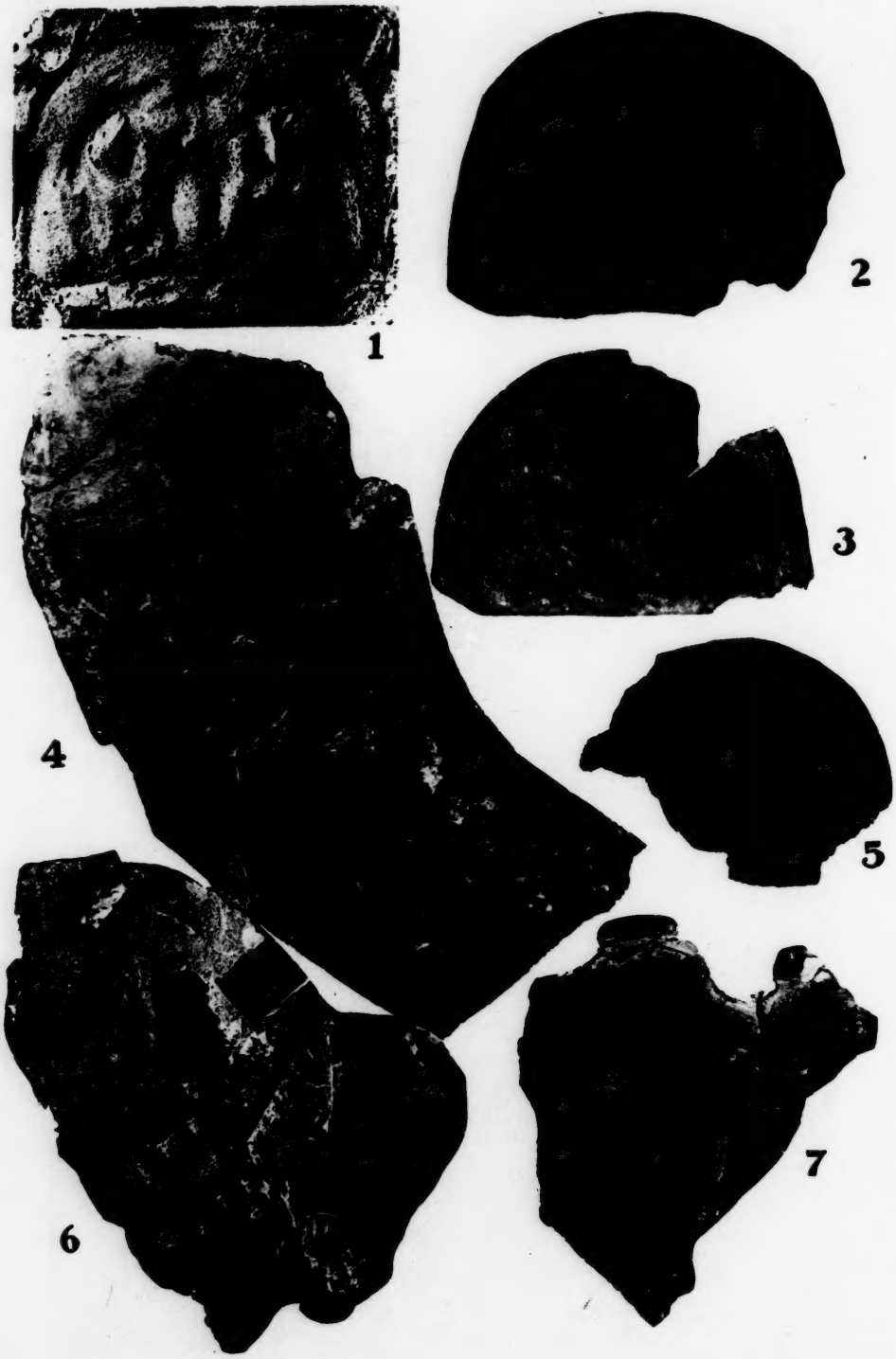
1

4



2

3


1
2
3
4
5
6
7

TYLOPTERELLA BOYLEI (Whiteaves)

Eurypterus boylei WHITEAVES, 1884, p. 42, pl. 7, fig. 3; MILLER, 1889, p. 548; SARLE, 1903, p. 1081; CLARKE, 1909, p. 37; WOODWARD, 1913, p. 298; POMPECKJ, 1923, BROOKS, 1957, p. 898.
Eurypterus (Tylopterus) boylei CLARKE & RUEDEMANN, 1912, p. 218–219, fig. 42; CLARKE, 1913, p. 783; O'CONNELL, 1916, p. 42; DIENER, 1924, p. 21.
Tylopterella boylei STØRMER, 1955, p. 34, fig. 29.

The genus and species remain known from only one nearly complete specimen. It is an unusual and apparently aberrant form, characterized by a greatly thickened exoskeleton, calcareo-chitinous, and reinforced by knobs along the axis of the mesosoma, and ornamented by ridges of confluent tubercles. As in other Guelph fossils, the thickening of the integument is ascribed by Clarke & Ruedemann (1912, p. 217) to the strongly saline water and in part to the life of the organism on wave-beaten coral reefs. It is more likely to the author that the former is the cause of the thickening rather than the latter.

T. boylei is much like species of the genus *Erieopterus*, such as *E. microphthalmus microphthalmus* (Hall) and *E. microphthalmus eriensis* (Whitfield) except for the peculiar ornamentation and bosses. It is suggested that *T. boylei* developed directly from *Erieopterus*.

Distribution: Ontario.

Stratigraphic range: Silurian: Guelph dolomite, associated with marine fossils.

A check list of the family Eurypteridae, as defined above, follows. The column on the left represents the specific name used by the authors, including this report, whereas the right column represents the specific name that is recognized here.

EXPLANATION OF PLATE 148

FIG. *1*—Holotype of *Eurypterus remipes laculatus* Kjellesvig-Waering, n. ssp. (from Clarke & Ruedemann, 1912, pl. 6, fig. 6), Cobleskill dolomite, Morganville, New York, ×3 (original in the New York State Museum).

2—Ventral side of prosoma revealing the fluted, ventral shield of *Erieopterus microphthalmus eriensis* (Whitfield), Silurian, Put-in-Bay Dolomite of Bass Islands formation, at Beach Point, Put-in-Bay Island, Ohio, ×2 (no. 19571, in the Geological Museum, Ohio State University).

3—Carapace of *Erieopterus microphthalmus eriensis* (Whitfield) from same locality and horizon as figure *2*. This is an uncrushed mold. ×1⅔ (no. 155678 in the U. S. National Museum).

4—Mesoma and metasoma of *Erieopterus microphthalmus eriensis* (Whitfield) from same locality and horizon as figure *2*. Note prominent transverse ridge along the anterior of each tergite. This specimen is one of Whitfield's syntypes. ×1.3 (no. 3510 in the Geological Museum, Ohio State University).

5—A fragmentary carapace of *Erieopterus microphthalmus eriensis* (Whitfield) from same locality and horizon as figure *2*. The ocelli are well preserved (no. 3532, in the Geological Museum, Ohio State University).

6—Fragments of *Eurypterus pittsfordensis* Sarle from the Pittsford shale at Pittsford, New York, ×½. The slender telson, as well as an operculum, the detached tergites and a small individual retaining carapace, with swimming leg and mesosoma are preserved on this slab. (In the writer's collection.)

7—An unusually well preserved specimen of *Eurypterus pittsfordensis* Sarle from the same locality and horizon as figure *6*. Although the photograph cannot reveal the details as there is insufficient contrast in the specimen and matrix, this specimen retains the ventral shield, the female operculum, the entire swimming leg, metastoma and the mesosoma. All are preserved from the inside (dorsal). This specimen is illustrated further in plate 145, figures 4,5, and in text-figures 20,21,24,25 and 26. ×⅔. (In the writer's collection.)

CHECK LIST OF FAMILY EURYPTERIDAE

Previous status:	Present status:
Dolichopterus cumberlandicus Swartz: Swartz 1923, pl. 67, fig. 3 (*partim*)	= ... *Eurypterus remipes swartzi* Kjellesvig-Waering
Erieopterus brewsteri (Woodward)	= ... *Erieopterus brewsteri* (Woodward)
Erieopterus chadwicki (Clarke & Ruedemann)	= ... *Erieopterus chadwicki* (Clarke & Ruedemann)
Erieopterus hudsonicus (Clarke & Ruedemann)	= ... *Erieoptreus hudsonicus* (Clarke & Ruedemann)
Erieopterus hypsophthalmus Kjellesvig-Waering	= ... *Erieopterus hypsophthalmus* Kjellesvig-Waering
Erieopterus laticeps (Schmidt)	= ... *Erieopterus laticeps* (Schmidt)
Erieopterus latus (Ruedemann)	= ... *Erieopterus latus* (Ruedemann)
Erieopterus limuloides (Kjellesvig-Waering)	= ... *Erieopterus limuloides* (Kjellesvig-Waering)
Erieopterus microphthalmus eriensis (Whitfield)	= ... *Erieopterus microphthalmus eriensis* (Whitfield)
Erieopterus microphthalmus microphthalmus (Hall)	= ... *Erieopterus microphthalmus microphthalmus* (Hall)
Erieopterus pustulosus (Hall)	= ... *Erieopterus pustulosus* (Hall)
Erieopterus statzi (Størmer)	= ... *Erieopterus statzi* (Størmer)
Eurypterus abbreviatus Salter	= ... *Salteropterus abbreviatus* (Salter)
Eurypterus acrocephalus Semper	= ... *Carcinosoma acrocephalum* (Semper)
Eurypterus acuminatus Salter	= ... *Hughmilleria acuminata* (Salter)
Eurypterus (*Adelophthalmus*) *carbonarius* Chernishev	= ... *Adelophthalmus carbonarius* (Chernishev)
Eurypterus (*Adelophthalmus*) *granosus* (Jordan) Waterlot, 1934	= ... *Adelophthalmus granosus* (Jordan & Meyer)
Eurypterus (*Adelophthalmus*) *granosus* Jordan & Meyer	= ... *Adelophthalmus granosus* (Jordan & Meyer)
Eurypterus (*Anthraconectes*) *approximatus* Hall & Clarke	= ... *Adelophthalmus approximatus* (Hall & Clarke)
Eurypterus (*Anthraconectes*) *brasdorensis* Bell	= ... *Adelophthalmus brasdorensis* (Bell)
Eurypterus (*Anthraconectes*) *cambieri* Pruvost	= ... *Adelophthalmus cambieri* (Pruvost)
Eurypterus (*Anthraconectes?*) *chinensis* Grabau	= ... *Adelophthalmus chinensis* (Grabau)
Eurypterus (*Anthraconectes*) *corneti* Pruvost	= ... *Adelophthalmus corneti* (Pruvost)
Eurypterus (*Anthraconectes*) *mansfieldi* C. E. Hall	= ... *Adelophthalmus mansfieldi* (C. E. Hall)
Eurypterus (*Anthraconectes*) *mazonensis* Meek & Worthen	= ... *adelophthalmus mazonensis* (Meek & Worthen)
Eurypterus (*Anthraconectes*) *cf. moyseyi* (Woodward): Van der Heide, 1951	= ... *Adelophthalmus* cf. *moyseyi* (Woodward)
Eurypterus (*Anthraconectes*) *nebraskensis* Barbour	= ... *Adelophthalmus nebraskensis* (Barbour)
Eurypterus (*Anthraconectes*) *pennsylvanicus* (C. E. Hall)	= ... *Adelophthalmus pennsylvanicus* (C. E. Hall)
Eurypterus (*Anthraconectes*) *sellardsi* Dunbar	= ... *Adelophthalmus sellardsi* (Dunbar)
Eurypterus approximatus Hall & Clarke	= ... *Adelophthalmus approximatus* (Hall & Clarke)
Eurypterus arnoldi Ehlers	= ... *Stylonurus arnoldi* (Ehlers)
Eurypterus? (*Arthropleura*) *ferox* Salter	= ... not an eurypterid: *Euphoberia ferox* (Salter)
Eurypterus (*Arthropleura*)? *mammatus* Salter	= ... not an eurypterid: *Arthropleura mammatus* (Salter)
Eurypterus beecheri Hall	= ... *Stylonurus beecheri* (Hall)
Eurypterus beecheri Hall & Clarke	= ... *Stylonurus beecheri* (Hall)
Eurypterus bohemicus Barrande (1865)	= ... nomen nudum
Eurypterus boylei Whiteaves	= ... *Tylopterella boylei* (Whiteaves)
Eurypterus brewsteri Woodward	= ... *Erieopterus brewsteri* (Woodward)
Eurypterus brodiei Woodward	= ... *Eurypterus cephalaspis* Salter
Eurypterus brodiei Woodward: Woodward 1871, figs. 2–3	= ... *Hughmilleria banksii* (Salter)
Eurypterus cephalaspis Salter	= ... *Eurypterus cephalaspis* Salter
Eurypterus (?) *cestrotus* Clarke	= ... *Clenopterus cestrotus* (Clarke)
Eurypterus chadwicki Clarke & Ruedemann	= ... *Erieopterus chadwicki* (Clarke & Ruedemann)
Eurypterus chartarius Salter	= ... *Hughmilleria lanceolata* (Salter)
Eurypterus? cicerops Clarke	= ... *Carcinosoma cicerops* (Clarke)
Eurypterus? clevelandi Walcott	= ... *Echinognathus clevelandi* (Walcott)
Eurypterus conicus Laurie	= ... *Hughmilleria conica* (Laurie)
Eurypterus cyclophthalmus Laurie	= ... *Eurypterus cyclophthalmus* Laurie
Eurypterus decipiens Ruedemann	= ... *Eurypterus? decipiens* Ruedemann
Eurypterus dekayi Hall	= ... *Eurypterus dekayi* Hall
Eurypterus derbiensis Woodward	= ... *Adelophthalmus moyseyi* (Woodward)
Eurypterus (?) *dewalquei* Fraipont	= ... *Adelophthalmus? dewalquei* Fraipont
Eurypterus (?) *dewalquei* Fraipont var. *longimanus* Fraipont	= ... *Adelophthalmus? dewalquei* Fraipont
Eurypterus (*Dolichopterus*) *macrocheirus* Hall	= ... *Dolichopterus macrocheirus* Hall
Eurypterus (*Dolichopterus*) *mansfieldi* C. E. Hall	= ... *Adelophthalmus mansfieldi* (C. E. Hall)
Eurypterus? (*Dolichopterus?*) *prominens* Hall	= ... *Hughmilleria? prominens* (Hall)
Eurypterus (*Dolichopterus?*) *prominens* Hall	= ... *Hughmilleria? prominens* (Hall)
Eurypterus? (*Dolichopterus?*) *stellatus* Clarke & Ruedemann	= ... *Dolichopterus? stellatus* (Clarke & Ruedemann)
Eurypterus (*Dolichopterus?*) *stellatus* Clarke & Ruedemann: Diener 1924	= ... *Dolichopterus? stellatus* (Clarke & Ruedemann)

CHECK LIST OF FAMILY EURYPTERIDAE (*continued*)

Previous status:	Present status:
Eurypterus dolichoschelus Laurie	= ....*Mixopterus dolichoschelus* (Laurie) Størmer
Eurypterus douvillei DeLima	= ....*Adelophthalmus douvillei* (DeLima)
Eurypterus dumonti Stainier	= ....*Adelophthalmus dumonti* (Stainier)
Eurypterus? dumonti Stainier (Kjellesvig-Waering, 1948)	= ....*Adelophthalmus dumonti* (Stainier)
Eurypterus (*Echinognathus*) *clevelandi* (Walcott)	= ....*Echinognathus clevelandi* (Walcott)
Eurypterus eriensis Whitfield	= ....*Erieopterus microphthalmus eriensis* (Whitfield)
Eurypterus? (Euphoberia) ferox Salter	= ....not an eurypterid: *Euphoberia ferox* (Salter)
Eurypterus (*Eusarcus*) *scorpionis* (Grote & Pitt)	= ....*Carconosoma scorpionis* (Grote & Pitt)
Eurypterus fischeri Eichwald	= ....*Eurypterus remipes tetragonophthalmus* Fischer
Eurypterus fischeri Holm (Van Oyen, 1956)	= ....*Eurypterus remipes tetragonophthalmus* Fischer
Eurypterus fischeri Eichwald: Schmidt, 1883, p. 50 (*E. linearis*)	= ....*Eurypterus caphalaspis* Salter
Eurypterus fischeri var. *rectangularis* Schmidt	= ....*Eurypterus remipes tetragonophthalmus* Fischer
Eurypterus flintstonensis Swartz	= ....*Eurypterus remipes flintstonensis* Swartz
Eurypterus giganteus Pohlman	= ....*Erieopterus pustulosus* (Hall)
Eurypterus grandis (Grote & Pitt): Miller 1889	= ....*Carcinosoma scorpionis* (Grote & Pitt)
Eurypterus granosus (Jordan & Meyer)	= ....*Adelophthalmus granosus* Jordan & Meyer
Eurypterus "de Houthaelen" Stainier (Van Oyen, 1956)	= ....*Adelophthalmus* sp. Stainier
Eurypterus "d'Havre" Stainier (Van Oyen, 1956)	= ....*Adelophthalmus* sp. Stainier
Eurypterus hibernicus Baily	= ....*Adelophthalmus* (?) *hibernicus* (Baily)
Eurypterus (*Hughmilleria?*) *maria* Clarke: Kjellesvig-Waering 1948	= ....new genus
Eurypterus hudsonicus Ruedemann	= ....*Erieopterus hudsonicus* (Ruedemann)
Eurypterus imhofi (Reuss)	= ....*Adelophthalmus imhofi* (Reuss)
Eurypterus kokomoensis Miller & Gurley	= ....*Onychopterella kokomoensis* (Miller & Gurley)
Eurypterus lacustris Harlan	= ....*Eurypterus remipes lacustris* Harlan
Eurypterus lacustris Harlan (Claypole, 1890)	= ....*Onychopterella kokomoensis* (Miller & Gurley)
Eurypterus lacustris Harlan (Kindle, 1913)	= ....*Onychopterella kokomoensis* (Miller & Gurley)
Eurypterus lacustris Harlan (Salter, 1895)	= ....*Eurypterus remipes remipes* DeKay
Eurypterus lacustris Hibbert	= ....*Eurypterus remipes lacustris* Harlan
Eurypterus lacustris var. *pachycheirus* Hall	= ....*Eurypterus remipes lacustris* Harlan
Eurypterus lacustris var. *robustus* Hall	= ....*Eurypterus remipes lacustris* Harlan
Eurypterus lanceolatus Salter	= ....*Hughmilleria lanceolata* (Salter)
Eurypterus lancmani Delle	= ....*Dolichopterus lancmani* (Delle)
Eurypterus latus Ruedemann	= ....*Erieopterus latus* (Ruedemann)
Eurypterus laticeps Schmidt	= ....*Erieopterus laticeps* (Schmidt)
Eurypterus leptonotus Barrande (MS) (Bigsby, 1868, p. 198)	= ....nomen nudum
Eurypterus linearis Salter	= ....*Eurypterus cephalaspis* Salter
Eurypterus lohesti Dewalque	= ....*Adelophthalmus? lohesti* Dewalque
Eurypterus ? mammatus Salter	= ....not an eruypterid: *Arthropleura mammatus.* (Salter)
Eurypterus mansfieldi C. E. Hall	= ....*Adelophthalmus mansfieldi* (C. E. Hall)
Eurypterus maria Clarke	= ....new genus
Eurypterus maria Clarke (Clarke 1907, pl. 2, fig. 3)	= ....*Pterygotus* (*Errettopterus*) *globiceps* Clarke & Ruedemann
Eurypterus maria Clarke (Clarke 1907, pl. 3, fig. 6)	= ....*Stylonurus myops* (Clarke)
Eurypterus? maria Clarke	= ....New genus
Eurypterus mazonensis Meek & Worthen	= ....*Adelophthalmus mazonensis* (Meek & Worthen)
Eurypterus megalops Clarke & Ruedemann	= ....*Drepanopterus ? ruedemanni* (O'Connell)
Eurypterus megalops Salter	= ....*Stylonurus megalops* (Salter)
Eurypterus microphthalmus Clarke & Ruedemann (Van Oyen, 1956)	= ....*Erieopterus microphthalmus microphthalmus* (Hall)
Eurypterus microphthalmus Hall	= ....*Erioepterus microphthalmus microphthalmus* (Hall)
Eurypterus minor Laurie	= ....*Eurypterus minor* Laurie
Eurypterus minutisculptus (Peach) (Waterston, 1957)	= ....*Campylocephalus? minutisculptus* (Peach)
Eurypterus minutus Kiaer	= ....*Hughmilleria norvegica* (Kaier)
Eurypterus moyseyi Woodward	= ....*Adelophthalmus moyseyi* (Woodward)
Eurypterus myops Clarke	= ....*Stylonurus myops* (Clarke)
Eurypterus nebrascensis Barbour (Dunbar, 1924)	= ....*Adelophthalmus nebraskensis* (Barbour)
Eurypterus norvegicus Kiaer	= ....*Hughmilleria norvegica* (Kiaer)
Eurypterus obesus Woodward	= ....*Carcinosoma obesum* (Woodward)
Eurypterus oklahomensis Decker	= ....*Adelophthalmus sellardsi* (Dunbar)
Eurypterus (*Onychopterus*) *kokomoensis* Miller & Gurley	= ....*Onychopterella kokomoensis* (Miller & Gurley)
Eurypterus? overathi Gross	= ....*Grossopterus overathi* (Gross)

CHECK LIST OF FAMILY EURYPTERIDAE (*continued*)

Previous status:	Present status:
Eurypterus pachycheirus Hall	= ... *Eurypterus remipes lacustris* Harlan
Eurypterus pennsylvanicus C. E. Hall	= ... *Adelophthalmus pennsylvanicus* (C. E. Hall)
Eurypterus pittsfordensis Sarle	= ... *Eurypterus pittsfordensis* Sarle
Eurypterus potens Hall	= ... *Adelophthalmus potens* (Hall)
Eurypterus pristinus Clarke & Ruedemann	= ... *Eurypterus? pristinus* Clarke & Ruedemann
Eurypterus prominens Hall	= ... *Hughmilleria? prominens* (Hall)
Eurypterus? prominens Hall: Pompeckj, 1923	= ... *Hughmilleria? prominens* (Hall)
Eurypterus pugio Barrande	= ... not an eurypterid: *Phasgonocaris pugio* (Barrande)
Eurypterus pulicaris Salter	= ... not an eurypterid
Eurypterus punctatus Salter	= ... *Carcinosoma punctatum* (Salter)
Eurypterus punctatus Woodward et *acrocephalus* Semper (Seemann, 1906)	= ... *Carcinosoma acrocephalum* (Semper)
Eurypterus pustulosus Hall	= ... *Erieopterus pustulosus* (Hall)
Eurypterus pygmaeus Salter	= ... *Hughmilleria pygmaea* (Salter)
Eurypterus? cf. pygmaea Salter (Salter 1859, fig. 20)	= ... not an eurypterid: *Palaeophonus lightbodyi* Kjellesvig-Waering
Eurypterus cf.? pygmaeus Salter: Schluter, 1881	= ... *Hughmilleria pygmaea* (Salter)
Eurypterus ranilarva Clarke & Ruedemann	= ... *Onychopterella kokomoensis* (Miller & Gurley)
Eurypterus remipes DeKay	= ... *Eurypterus remipes remipes* DeKay
Eurypterus remipes DeKay (Bronn & Roemer, 1854)	= ... *Eurypterus remipes lacustris* Harlan
Eurypterus remipes DeKay (Clarke & Ruedemann, 1912, pl. 6, fig. 6)	= ... *Eurypterus remipes laculatus* Kjellesvig-Waering
Eurypterus remipes DeKay (Eichwald, 1854)	= ... *Eurypterus remipes tetragonophthalmus* Fischer
Eurypterus remipes DeKay (Gerstacker, 1879)	= ... *Eurypterus remipes tetragonophthalmus* Fischer
Eurypterus remipes DeKay (Grabau, 1901)	= ... *Eurypterus remipes lacustris* Harlan
Eurypterus remipes DeKay (Keyserling 1853)	= ... *Eurypterus remipes tetragonophthalmus* Fischer
Eurypterus remipes DeKay (Kindle, 1934, fig. 2)	= ... *Eurypterus remipes lacustris* Harlan
Eurypterus remipes DeKay (Kindle 1934, fig. 1)	= ... *Eurypterus remipes quebecensis* Kjellesvig-Waering
Eurypterus remipes DeKay ? (Lesley, 1889)	= ... *Adelophthalmus pennsylvanicus* (Hall)
Eurypterus remipes DeKay (Logan, 1863)	= ... *Eurypterus remipes lacustris* Harlan
Eurypterus remipes DeKay ? (Miller, 1889)	= ... *Proscorpius osborni* Whitfield
Eurypterus remipes DeKay (Murchison, 1856)	= ... *Eurypterus remipes tetragonophthalmus* Fischer
Eurypterus remipes DeKay (Nieszkowski, 1859)	= ... *Eurypterus remipes tetragonophthalmus* Fischer
Eurypterus remipes DeKay (Northrop, 1938)	= ... *Eurypterus remipes quebecensis* Kjellesvig-Waering
Eurypterus remipes DeKay (Pictet, 1853)	= ... *Eurypterus remipes lacustris* Harlan
Eurypterus remipes DeKay (Roemer, 1848)	= ... *Eurypterus remipes tetragonophthalmus* Fischer
Eurypterus remipes DeKay (Roemer, 1876)	= ... *Eurypterus remipes tetragonophthalmus* Fischer
Eurypterus remipes DeKay (Salter, 1856)	= ... *Eurypterus remipes tetragonophthalmus* Fischer
Eurypterus remipes DeKay (Schmidt 1858)	= ... *Eurypterus remipes tetragonophthalmus* Fischer
Eurypterus remipes DeKay (Schmidt, 1859)	= ... *Eurypterus remipes tetragonophthalmus* Fischer
Eurypterus remipes DeKay (Schrenk, 1854)	= ... *Eurypterus remipes tetragonophthalmus* Fischer
Eurypterus remipes flintstonensis Swartz	= ... *Eurypterus remipes flintstonensis* Swartz
Eurypterus remipes laculatus Kjellesvig-Waering	= ... *Eurypterus remipes laculatus* Kjellesvig-Waering
Eurypterus remipes lacustris Harlan	= ... *Eurypterus remipes lacustris* Harlan
Eurypterus remipes quebecensis Kjellesvig-Waering	= ... *Eurypterus remipes quebecensis* Kjellesvig-Waering
Eurypterus remipes remipes DeKay	= ... *Eurypterus remipes remipes* DeKay
Eurypterus remipes swartzi Kjellesvig-Waering	= ... *Eurypterus remipes swartzi* Kjellesvig-Waering
Eurypterus remipes tetragonophthalmus Fischer	= ... *Eurypterus remipes tetragonophthalmus* Fischer
Eurypterus robustus Hall	= ... *Eurypterus remipes lacustris* Harlan
Eurypterus ruedemanni O'Connell	= ... *Drepanopterus? ruedemanni* (O'Connell)
Eurypterus rusti Ruedemann	= ... *Stylonurus? rusti* (Ruedemann)
Eurypterus (?) *rusti* Ruedemann	= ... *Stylonurus? rusti* (Ruedemann)
Eurypterus? salmi Stur	= ... *Campylocephalus? salmi* (Stur)
Eurypterus scorpioides Woodward	= ... *Carcinosoma scorpioides* (Woodward)
Eurypterus scorpioides Woodward (Laurie, 1892)	= ... *Carcinosoma scoticum* (Laurie)
Eurypterus scorpionis Grote & Pitt	= ... *Carcinosoma scorpionis* (Grote & Pitt)
Eurypterus scoticus Laurie	= ... *Carcinosoma scoticum* (Laurie)
Eurypterus scouleri Hibbert	= ... *Campylocephalus scouleri* (Hibbert)
Eurypterus (?) *scouleri*	= ... *Campylocephalus scouleri* (Hibbert)
Eurypterus scouleri Hibbert ? Page, 1867	= ... *Campylocephalus? stevensoni* (Etheridge)
Eurypterus scouleri ? Hibbert: Salter, 1859	= ... *Adelophthalmus? hibernicus* (Bailey)
Eurypterus simonsoni Schmidt	= ... *Mixopterus simonsoni* (Schmidt)
Eurypterus sp. Barbour (1914)	= ... *Adelophthalmus nebraskensis* (Barbour)

CHECK LIST OF FAMILY EURYPTERIDAE (*continued*)

Previous status:	Present status:
Eurypterus sp. Clarke & Ruedemann 1912, p. 87, Sil. Arisaig, Nova Scotia	= . . . . *Eurypterus? sp.* Clarke & Ruedemann
Eurypterus sp. Dawson 1871 (Dev., Gaspé Bay, Quebec)	= . . . . *Eurypterus? sp.* Dawson
Eurypterus sp. Dehee (1928, Dev., France)	= . . . . *Erieopterus? sp.* Dehee
Eurypterus sp. Kjellesvig-Waering (1950, Sil. W.Va.)	= . . . . *Eurypterus sp.* Kjellesvig-Waering
Eurypterus (?) *sp.* Kjellesvig-Waering (this report, Sil., Ohio)	= . . . . *Eurypterus* (?) *sp.* Kjellesvig-Waering
Eurypterus sp. Moberg (1910, Sil., Sweden)	= . . . . *Eurypterus?* sp. Moberg
Eurypterus sp. Moysey (1911 Carb., England)	= . . . . *Adelophthalmus* sp. Moysey
Eurypterus sp. Peach & Horne, 1899, p. 585 (Monkshead, Scotland)	= . . . . *Eurypterus* sp. Peach & Horne
Eurypterus sp. Peach & Horne (1899, Sil., Birkenhead Burn, Scotland)	= . . . . *Eurypterus* sp. Peach & Horne
Eurypterus sp. Peach & Horne (1899, Sil., Girvan, Scotland)	= . . . . *Eurypterus* sp. Peach & Horne
Eurypterus sp. Pruvost 1911	= . . . . *Adelophthalmus sp.* Pruvost
Eurypterus sp. Pruvost 1919 (Carb., France)	= . . . . *Adelophthalmus sp.* Pruvost
Eurypterus? sp. Ruedemann 1934, p. 380 (Ord., New York)	= . . . . *Eurypterus* ? *sp.* Ruedemann
Eurypterus? sp. Salter (Carb., Nova Scotia)	= . . . . *Hastimima* ? *sp.* Salter
Eurypterus sp. Schmitz & Stainier, 1910	= . . . . *Adelophthalmus dumonti* (Stainier)
Eurypterus sp.? Seeman, 1906	= . . . . indeterminable spine
Eurypterus sp. Stainier, 1935 (Carb., d'Havre, Belgium)	= . . . . *Adelophthalmus* sp. (Stainier)
Eurypterus sp. Stainier, 1935 (Carb., Houthaelen, Belgium)	= . . . . *Adelophthalmus* sp. (Stainier)
Eurypterus sp. Størmer 1936 (Dev. Germany)	= . . . . *Eurypterus sp.* Størmer
Eurypterus sp. Størmer (1934; Dev., Spitzbergen)	= . . . . *Eurypterus sp.* Størmer
Eurypterus sp. Susta (1932)	= . . . . *Adelophthalmus zadrai* Pribyl
Eurypterus sp. Tilton (Wills Creek, W.Va).	= . . . . *Eurypterus sp.* Tilton
Eurypterus sp. Vascăuţănu (1932) Sil., Hotin beds, Romania	= . . . . *Eurypterus sp.* Vascăuţănu
Eurypterus sp. ind. O'Connell 1916, p. 51	= . . . . *Adelophthalmus potens* Hall
Eurypterus sp. ind. aff. *punctato* (Salter) et *acrocephalo* (Semper) (Diener, 1924)	= . . . . *Carcinosoma acrocephalum* (Semper)
Eurypterus sp. nov. Powrie, 1864	= . . . . *Erieopterus brewsteri* (Woodward)
Eurypterus statzi Størmer	= . . . . *Erieopterus statzi* (Størmer)
Eurypterus stevensoni Etheridge: Woodward, 1877, Etheridge 1888	= . . . . *Campylocephalus? stevensoni* (Etheridge)
Eurypterus? stevensoni Etheridge	= . . . . *Campylocephalus? stevensoni* (Etheridge)
Eurypterus stellatus Clarke & Ruedemann: Woodward 1913	= . . . . *Dolichopterus* (?) *stellatus* (Clarke & Ruedemann)
Eurypterus? (Stylonurus?) beecheri Hall: Woodward 1888	= . . . . *Stylonurus beecheri* (Hall)
Eurypterus (Stylonurus?) maccarthyi Kjellesvig-Waering	= . . . . *Rhenopterus? maccarthyi* Kjellesvig-Waering
Eurypterus stylus Hall	= . . . . *Adelophthalmus mansfieldi* (C. E. Hall)
Eurypterus symondsii Salter	= . . . . *Stylonurus symondsii* (Salter)
Eurypterus tetragonophthalmus Fischer	= . . . . *Eurypterus remipes tetragonophthalmus* Fischer
Eurypterus tetragonophthalmus Fischer (Hall, 1884)	= . . . . *Eurypterus remipes remipes* DeKay?
Eurypterus tetragonophthalmus Fischer (Miller, 1877)	= . . . . *Eurypterus remipes remipes* DeKay?
Eurypterus tetragonophthalmus Fischer (Miller, 1889)	= . . . . *Eurypterus remipes remipes* DeKay?
Eurypterus thomasi Walter	= . . . . not an eurypterid: *Glypharthrus thomasi* (Walter)
Eurypterus (Tylopterus) boylei Whiteaves)	= . . . . *Tylopterella boylei* (Whiteaves)
Eurypterus wilsoni Woodward	= . . . . *Adelophthalmus wilsoni* (Woodward)
Eurypterus cf. *wilsoni* Woodward (Moore, 1936)	= . . . . *Adelophthalmus wilsoni* (Woodward)
Homalonotus? cephalaspis Salter	= . . . . nomem nudum
Hughmilleria linearis (Salter): Størmer 1934	= . . . . *Eurypterus cephalaspis* Salter
Hughmilleria? linearis (Salter); Størmer, 1934; Kjellesvig-Waering 1950	= . . . . *Eurypterus cephalaspis* Salter
Lepidoderma (Eurypterus) granosum Jordan & Meyer (Reuss 1855)	= . . . . *Adelophthalmus granosus* Jordan & Meyer
Onychopterella kokomoensis (Miller & Gurley)	= . . . . *Onychopterella kokomoensis* (Miller & Gurley)
Onychopterella kokomoensis (Miller & Gurley)	= . . . . *Onychopterella kokomoensis* (Miller & Gurley)
Onychopterella pumilus (Savage)	= . . . . *Onychopterella pumilus* (Savage)
Onychopterus kokomoensis (Miller & Gurley)	= . . . . *Onychopterella kokomoensis* (Miller & Gurley)
Onychopterus limuloides Kjellesvig-Waering	= . . . . *Erieopterus limuloides* (Kjellesvig-Waering)
Onychopterus pumilus (Savage)	= . . . . *Onychopterella pumilus* (Savage)
Pterygotus globicaudatus Pohlman	= . . . . *Erieopterus pustulosus* (Hall)
Tylopterella boylei (Whiteaves)	= . . . . *Tylopterella boylei* (Whiteaves)
Tylopterus boylei (Whiteaves): Clarke, 1913	= . . . . *Tylopterella boylei* (Whiteaves)

BIBLIOGRAPHY

AGASSIZ, L., 1860, Morphology of the genus *Eurypterus:* Proc. Am. Acad. Sci., v. 4, p. 353.

BANKS, R. W., 1856, On the Tilestones or Downton Sandstones, in the neighbourhood of Kington, and their contents: Quart. Geol. Soc., London, v. 12, p. 93–102, 1 pl.

BARBOUR, E. H., 1912, Notice of newly discovered eurypterids in Nebraska: Science, v. 36, p. 642–643.

——, 1914, Carboniferous eurypterids of Nebraska: Am. Jour. Sci., 4th ser., v. 38, p. 507–510.

——, 1914, Eurypterid Beds of Nebraska with notice of a new species, *Eurypterus nebraskensis:* Nebr. Geol. Survey, v. IV, pt. 12, p. 193–203, 2 pls.

BARRANDE, J., 1856, Parallèle entre les dépôts de Bohême et de Scandinavie: Abh. K. böhm. Ges. Wiss., v. 9, Prague.

——, 1865: III. Étude général sur nos étages G-H avec application spécial dux environs de Hlubocepy. Prague.

BELL, W. A., 1922, A new genus of Characeae and new Merostomata from the Coal Measures of Nova Scotia: Trans. Royal Soc. Canada: sec. 4, p. 159–167, 1 pl.

BIGSBY, J. J., 1859, An inquiry into the sedimentary and other external relations of the Palaeozoic fossils of the state of New York: Quart. Jour. Geol. Soc., London, v. 15, p. 251–335.

——, 1868, Thesaurus Siluricus, London.

BRANSON, C. C., 1948, Bibliographic index of Permian invertebrates: Geol. Soc. America Mem. 26, 1049 p.

BRODIE, P. B., 1869, On the occurrence of remains of *Eurypterus* and *Pterygotus* in the Upper Silurian rocks of Herefordshire: Quart. Jour. Geol. Soc., London, v. 25, p. 235–237.

——, 1871, On the "Passage-beds" in the neighbourhood of Woolhope, Herefordshire, and on the discovery of a new species of *Eurypterus*, and some new land-plants in them: Geol. Mag., v. 8, p. 230.

BRONN, H. G., & ROEMER, F., 1850–56, Lethea Geognostica, v. 1–2.

BROOKS, H. K., 1957, *in* LADD, H. S., Treatise on marine ecology and paleoecology: Geol. Soc. America Mem. 67, p. 895–908 (Chelicerata and others).

BROWN, D. J., & HENDERSON, J., 1870, On the Silurian rocks of the Pentland Hills: Trans. Edin. Geol. Soc., v. 1, p. 23–33,266–272, pl. VIII.

BURMEISTER, H., 1843, Die Organisation der Trilobiten, etc., p. 61–62, 3 pls., Berlin.

——, 1846, The Organization of trilobites deduced from living affinities with a systematic review of species hitherto described: Roy. Soc., 136 p.

CASTER, K. E., & KJELLESVIG-WAERING, E. N., 1951, Concerning the eurypterid *Megalograptus*, an Upper Ordovician anachronism: Bull., Geol. Soc. America (abstract), v. 62, p. 1428–1429.

——, & ——, 1956, Some notes on the genus *Dolichopterus* Hall: Jour. Paleontology, v. 30, p. 19–29, pl. 4.

CHERNISHEV, B. I., 1933, Arthropoda from the Urals and other regions of the U.S.S.R.: Mater. Central Geol. Inst. U.S.S.R.—Paleont. & Stratigr., no. 1, p. 15–24.

CLARKE, J. M., 1903, Type specimens of Paleozoic fossils: N. Y. State Mus. Bull., no. 65, 847 p.

——, 1907, The Eurypterus shales of the Shawangunk Mountains in eastern New York: N. Y. State Mus. Bull., no. 107, p. 295–326, 10 pls.

——, 1909, Fifth report of the director of the science division, etc., N. Y. State Mus., Bull., no. 133, p. 35–38, pls. 1,2.

——, 1913, *in* Eastman's Zittel's Text-Book of paleontology, v. 1, 839 p.

——, 1913, Dalhousie and the Gaspé Peninsula: Canada Geol. Survey, Guide Book, I, pl. 1, p. 85–118.

——, & RUEDEMANN, R., 1911, Introduction to the monograph on Eurypterida: 1910 Rpt. of the Director; N. Y. State Mus. Bull., no. 149, p. 31.

——, & ——, 1912, The Eurypterida of New York: N. Y. State Mus., Mem. 14, 439 p., 88 pls.

CLAYPOLE, E. W. 1890, Palaeontological notes from Indianapolis: Am. Geologist, v. 6., p. 255–260.

——, 1894, A new species of *Carcinosoma:* Am. Geologist, v. 13, p. 77–79, pl. 4.

CONRAD, T. A., 1841, Fifth annual report on the palaeontology of the state of New York: N. Y. State Geol. Survey, v. 5, p. 4–57.

CUMMINGS, E. R., & SHROCK, R. R., 1928, The geology of the Silurian rocks of northern Indiana: Indiana Dept. Cons. pub. 75, p. 117–121.

DAWSON, J. W., 1868, Acadian geology, 2nd ed., 694 p., 231 figs.

——, 1871, The fossil plants of the Devonian and Upper Silurian formations of Canada: Geol. Survey Canada, 92 p., 20 pls.

——, 1881, Notes on new Erian (Devonian) plants: Quart. Jour. Geol. Soc., London, v. 37, p. 299–308, 2 pls.

DECKER, C. E., 1938, A Permian eurypterid from Oklahoma: Jour. Paleontology, v. 12, p. 396–397.

DEHEE RENÉ, 1928, Découverte de *Pterygotus anglicus* à Lievin: Ann. Soc. géol. Nord., v. 52, p. 323–324.

DEKAY, J. E., 1825, Observations on a fossil crustaceous animal of the order Branchiopoda: N. Y. Lyc. Nat. History, Ann., v. i, p. 375–377, pl. 29.

——, 1828, Report on several fossil multilocular shells from the state of Delaware, with observations on a second specimen of the new fossil genus *Eurypterus:* N. Y. Lyc. Nat. History, Ann., v. 2, p. 273–279.

DELLE, N., 1932–1936, Devon-Ablagerungen, der Niederung von Zemgale, des Gebietes der Augszeme (Oberkurland) und Litauens: Acta Univ. Latviensis (Mat. u. Nat. Ser), I–II, 384 p., 14 pls.

DEMAREST, A. G., 1827, Observations sur un Crustacé fossils de l'ordre des Branchiopodes, par M. J. E. DeKay: Bull. des Sciences Na-

turelles et de Géol. (Published under direction of de Férussac). v. 11, p. 311–313, Paris.

DENISON, R. H., 1856, A review of the habitat of the earliest vertebrates: Fieldiana, Geology, v. 11, no. 8, p. 359–457.

DIENER, C., 1924, Fossilium Catalogus, I, Animalia, pt. 25, Eurypterida, p. 1–29, Berlin.

DUNBAR, C. O., 1924, Kansas Permian insects, Part 1, The geologic occurrence and the environment of the insects: Am. Jour. Sci., 5th ser., v. 7, p. 171–209, 2 pls.

EHLERS, G. M., 1935, A new eurypterid from the upper Devonian of Pennsylvania: Contrib. Mus. Paleontology Univ. Mich., v. 4, no. 18, p. 291–295, 1 pl.

EICHWALD, E., 1854, Die Grauwacken Schichten von Liev- und Esthland: Bull., Soc. Imp. des Naturalistes Moscou, v. 27, no. 1, p. 3.

——, 1857, Beitrag zur geographischen Verbreitung der fossilen Thiere Russlands: Bull. Soc. Imp. des Naturalistes Moscou, v. 30, no. 4, p. 305–354.

ELLES, G. L., & SLATER, I. L., 1906, The highest Silurian rocks of the Ludlow District: Quart. Jour. Geol. Soc., London, v. 62, p. 195–222, 1 pl.

ETHERIDGE, R., JR., 1877, On the remains of a crustacean, probably indicative of a new species of *Eurypterus*, or allied genus (*Eurypterus? Stevensoni*), from the Lower Carboniferous series (Cementstone group) of Berwickshire: Quart. Jour. Geol. Soc., London, v. 33, p. 223–228.

——, 1888, Fossils of the British Islands stratigraphically and zoologically arranged, v. 1, Palaeozoic.

FISCHER DE WALDHEIM, G., 1839, Notes sur un Crustacé fossils du genre *Eurypterus* de Podolie: Bull., Soc. Imp. des Naturalistes Moscou, v. 1, no. II, p. 125–128, pl. 7.

FRAIPONT, J., 1889, Eurypterides nouveaux du Dévonien supérieur de la Belgique: Ann. Soc. Géol. Belgique, v. 17, p. 53–62, pl. 2.

GEINITZ, H. B., 1856, Grundriss der Versteinerungskunde, 2nd Ed., 813 p., 28 pls., Leipzig.

GERSTAECKER, A., 1866–79, In Bronn's, Die Klassen und Ordnungen des Thier-Reichs wissenschaftlich dargestellt in Wort und Bild: Leipzig und Heidelberg.

GRABAU, A. W., 1901, Guide to the geology and Paleontology of Niagara Falls and vicinity: Buffalo Soc. Nat. Sci., Bull., v. 7, no. 1, 284 p.

——, 1920, A new species of *Eurypterus* from the Permian of China: Bull. Geol. Survey China, v. 2, p. 61–68, pl. IX.

——, & SHERZER, W. H., 1910, The Monroe formation of southern Michigan and adjoining regions: Michigan Geol. and Biol. Survey, pub. 2, Geol. Ser. I, no. 32, 248 p., pl. 32.

——, & SHIMER, H. W., 1910, North American index fossils, 2 v., 909 p.

GROSS, W., 1933, Die unterdevonischen Fische und Gigantostraken von Overath: Preuss. Geol. Landesanst., Abh N.F., v. 145, p. 41–77, 7 pls.

HALL, C. E., 1877, Contributions to paleontology from the museum of the Second Geological Survey: Am. Philos. Soc., Proc., v. 16, p. 621.

HALL, J., 1859, Paleontology of New York: N. Y. Geol. Survey, v. 3, Eurypterida, p. 382–424, pl. 80–84A.

——, 1860, On the genus *Eurypterus:* Albany Inst., Trans., v. 4, p. 280.

——, 1861, Relations of the genus *Eurypterus:* Am. Acad. Arts and Sci., Proc., v. 4, p. 353.

——, 1884, Eurypteridae from the lower productive Coal Measures in Beaver County and the lower Carboniferous Pithole shale in Venango County: 2nd Geol. Survey Penna., Rpt. Progress PPP, p. 23–39, 6 pls.

——, & CLARKE, J. M., 1888, Trilobites and other Crustacea of the Oriskany, Upper Helderberg, Hamilton, Portage, Chemung and Catskill groups: N. Y. Geol. Survey, Paleontology, v. 7, pt. 1, p. 1–236, 26 pls.

HARLAN, R., 1834, Critical notices of various organic remains hitherto discovered in North America: Geol. Soc. Penna., Trans., v. 1, p. 46–112, 1 pl.

HIBBERT, S., 1836, On the fresh-water limestone of Burdiehouse in the neighborhood of Edinburgh, belonging to the Carboniferous group of rocks, etc., Trans. Royal Soc. Edinburgh, v. 13, p. 169–282, pls. 5–12.

HOLM, G., 1896, Ueber eine neue Bearbeitung des *Eurypterus Fischeri* Eichw.: Acad. Imp. Sci., Bull., St. Petersbourg, ser. 5, v. 4, no. 4, p. 369–372.

——, 1898, Ueber die Organisation des *Eurypterus Fischeri* Eichw.: Mem. Acad. Imp. Sci., St. Petersbourg, ser. 8, v. 8, no. 2, p. 1–57, 10 pls.

——, 1897, Om forekomsten af en *Pterygotus* i Dalarnes Ofversilur, Geol. For. i Stockholm Forh., v. 19, no. 181, p. 475–478.

——, 1899, Palaeontologiska notiser 13. Om den yttre anatomien hos *Eurypterus Fischeri:* Geol. For. i Stockholm For., v. 21, p. 83–127, 4 pls.

——, 1902, Om Konskillnaden nos *Pterygotus osiliensis:* Geol. foren. forhandl., v. 24, no. 216, p. 375.

HUXLEY, T. H., 1855, Observations on the structures and affinities of *Himantopterus:* Quart. Jour. Geol. Soc., London, v. 12, p. 34–37.

——, & SALTER, J. W., 1859, On the anatomy and affinities of the genus *Pterygotus* (Huxley) and description of new species of *Pterygotus* (Salter): Mem. Geol. Surv. U.K., Mongr. 1, pt. 1–36, pt. II, p. 37–105, 16 pls.

JORDAN, H., & VON MEYER, H., 1854, Ueber die Crustaceen der Steinkohlenformation von Saarbrücken: Palaeontographica, v. 4, p. 1–15, pls. 1–2.

KJELLESVIG-WAERING, E. N., 1954, Note on a new eurypterid from the Moscow shales of New York: Am. Jour. Sci., v. 27, p. 386–387.

——, 1948, Two new eurypterids from the Silurian of Indiana: Jour. Paleontology, v. 22, p. 465–472, pls. 71,72.

——, 1948a, The Mazon Creek eurypterid: A revision of the genus *Lepidoderma:* Illinois State Mus., Sci. Papers, v. 3, no. 4, 46 p., 8 pls.

——, 1950, A new Silurian *Hughmilleria* from West Virginia: Jour. Paleontology, v. 24, p. 226–228, pl. 38, figs. 1,2.

——, 1951, Downtonian (Silurian) Eurypterida from Perton, near Stoke Edith, Herefordshire: Geol. Mag., v. 87, p. 1–24, 3 pls.

——, 1954, Note on a new Silurian scorpion from Shropshire, England: Jour. Paleontology, v. 28, p. 485–486.

KEYSERLING, GRAF., 1853, Bull. de la Soc. géol. de France, 2nd ser., v. XI, p. 153.

KIAER, J., 1911, A new Downtonian fauna in the sandstone series of the Kristiania Area: A Preliminary Report: Vidensk.-selsk. Skrifter, Kristiania, 1911, no. 7, p. 1–22.

KINDLE, E. M., 1913, The age of the eurypterids of Kokomo (Indiana): Am. Jour. Sci., ser. 4, v. 36, no. 213, p. 282–288.

——, 1934, A new Silurian eurypterid locality in eastern Canada: Royal Soc. Canada, Trans., 3rd ser., v. 28, sec. 4, p. 43–47, 1 pl.

KING, W. S., 1934, The Downtonian and Dittonian strata of Great Britain and North-Western Europe: Quart. Geol. Soc., London, v. 90, p. 526–566.

KUTORGA, S., 1838, Beitrag zur Kenntniss der organischen Ueberreste des Kupfersandsteins am westlichen Abhange des Urals. St. Petersburg, p. 1–38, pls. 1–7.

LAMONT, A., 1947, Gala-Tarannon beds in the Pentland Hills, near Edinburgh: Geol. Mag., v. 84, p. 193–208,289–303.

——, 1952, Ecology and correlation of the Pentlandian—a new subdivision of the Silurian system in Scotland: Rept. Int. Geol. Congr., 18 (Great Britain), pt. 10, p. 27–32.

——, 1955, Scottish Silurian Chelicerata: Trans., Edinburgh Geol. Soc., v. 16, pt. 2, p. 200–216, pls. 2–5.

LAURIE, M., 1892, On some eurypterid remains from the Upper Silurian rocks of the Pentland Hills: Trans., Royal Soc. Edinburgh, v. 37, pt. 1, no. 10, p. 151–161, 3 pls.

——, 1893, Recent additions to our knowledge of the Eurypterida: Nat. Sci., v. 3, no. 5, p. 124–127.

——, 1893a, The anatomy and relations of the Eurypteridae: Trans. Royal Soc. Edinburgh, v. 37, pt. 2, no. 24, p. 509–528, 2 pls.

——, 1894, The eurypterid-bearing deposits of the Pentland Hills: Rept. British Assoc. Adv. Sci., 64th meeting, p. 302–303.

——, 1899, On a Silurian scorpion and some additional eurypterid remains from the Pentland Hills: Trans. Royal Soc. Edinburgh, v. 39, pt. 3, p. 575–590, pls. 1–5.

——, 1899a, The eurypterid-bearing rocks of the Pentland Hills: Rept. British Assoc., 68th meeting, p. 557–558.

LESLEY, J. P., 1889, A dictionary of the fossils of Pennsylvania: 2nd Penn. Geol. Survey, Rept. P4, v. 1–3, 1283 p.

LEUTZE, W. P., 1956, Faunal stratigraphy of Syracuse formation, Onondaga and Madison Counties, New York: Am. Assoc. Petroleum Geologists Bull., v. 40, p. 1693–1698.

LIMA, W. DE, 1890, Note sur un Nouvel *Eurypterus* du Rothliegendes de Bussaco: Comm. Commissão dos Trabalhos Geol. de Portugal: v. 2, p. 153–157, 1 pl.

LINDSTROM, G., 1885, Förteckning pa Götland Siluriska Crustaceer: Ofversigt. Kongl. Vet. Akad. Forhandlingar, no. 6, 37 p., pls. 12–16.

Logan, W. E., 1863, Geology of Canada: Geol. Survey of Canada, Rept. of Progress to 1863, 983 p.

LUHA, A., 1950, Über Ergebnisse stratigraphischer Untersuchungen im Gebiete der Saaremaa-Osel)-Schichten in Eisti: Acta et comm. Univ. Tartuensis (Dorpatensis), v. 18, no. 6, p. 1–18.

MATTHEW, G. F., 1888, On some remarkable organisms of the Silurian and Devonian rocks in southern New Brunswick: Royal Soc. Canada, Trans., v. 6, sec. 4, p. 49–62, pl. 4.

MEEK, F. B., & WORTHEN, A. H., 1868, Preliminary notice of a scorpion, a *Eurypterus*? and other fossils from the Coal Measures of Illinois: Am. Jour. Sci., 2nd ser., v. 46, no. 136, p. 19–28.

MILLER, S. A., 1877, The American Paleozoic fossils: A catalogue of the genera and species, etc., 253 p., Cincinnati, Ohio.

——, & GURLEY, W. F. E., 1896, New species of Echinodermata and a new crustacean from the Paleozoic rocks: Illinois State Mus. Nat. Hist., Bull., no. 10, 91 p., 5 pls.

MILNE-EDWARDS, H., 1836, Hist. Nat. des Crustacés, 3 v., Paris, pt. 8, p. 422.

MITCHILL, S. L., 1818, An account of the impressions of a fish in the rocks of Oneida County, New York: American Monthly, v. 3, p. 291.

MOBERG, J. C., 1910, Historical-stratigraphical review of the Silurian of Sweden: Sver. Geol. Undersoknung, Ser. C., no. 229, 202 p.

MONAHAN, J. W., 1931, Studies of the fauna of the Bertie formation: Am. Midland Nat., v. 12, no. 10, p. 377–400, 4 pls.

MOORE, L. R., 1936, Some eurypterids from the English Coal Measures: Proc. Geol. Assoc., v. 47, pt. 4, p. 352–375.

MOYSEY, L., 1911, On some arthropod remains from the Nottinghamshire and Derbyshire Coal Field: Geol. Mag., v. 8, p. 497–507.

MURCHISON, R. L., 1853, On some of the remains in the Bone-Bed of the Upper Ludlow rock: Quart. Jour. Geol. Soc., London, v. 9, p. 16–17.

NIESZKOWSKI, J., 1858, De Eurypteri remipido: Dorpat.

——, 1859, Der *Eurypterus remipes* von der Insel Oesel: Arch. Naturgesch. Liv-Esth-, und Kurlands, ser. 1, v. 2.

NORTHROP, S. A., 1939, Paleontology and stratigraphy of the Silurian rocks of the Port Daniel-Black Cape Region, Gaspé: Geol. Soc. America Special Papers, no. 21, 302 p., 28 pls.

NOVAK, O., 1886, Note sur *Phasganocaris* nouveau Phyllocaride de l'étage Ff_2 en Bohême: Sitzb. K. Böhm. Ges. Wiss., p. 1–3, Prague.

O'CONNELL, M., 1916, The habitat of the Eurypterida: Bull. Buffalo Soc. Nat. Sci., v. 9, no. 3, 277 p.

PAGE, D., 1856, Advanced text-book of geology, 1st ed., London.

——, 1859, Advanced text-book of geology, 2nd ed., London.

PEACH, B. N., 1880, On some new crustaceans from the lower Carboniferous rocks of Eskdale and Liddesdale: Trans. Royal Soc. Edinburgh, v. 30, p. 73.

——, 1888, On a new eurypterid from the Upper Coal Measures of Radstock, Somersetshire: Proc., Royal Phys. Soc., v. 37, p. 438–445, pl. 20.

——, & HORNE, J., 1899, The Silurian rocks of Britain: Mem., Geol. Survey, U.K., v. 1, Scotland.

PICTET, F. J., 1854, Traité de Paléontologie, 2nd ed., Paris.

POHLMAN, J., 1881, On certain fossils of the Water-lime group near Buffalo: Buffalo Soc. Nat. Sci., Bull., v. 4, art. 3, p. 17.

——, 1882, Additional notes on the fauna of the Water-lime group near Buffalo: Buffalo Soc. Nat. Sci., Bull., v. 4, art. 4, p. 41.

——, 1886, Fossils from the Waterlime group near Buffalo, N. Y.: Buffalo Soc. Nat. Sci., Bull., v. 5, p. 23.

POMPECKJ, J. F., 1923, Gigantostraca und Scorpionida: Paläont. Zeitschr., Bd. 5, H. 3, p. 319–338.

POWRIE, J., 1864, On the fossiliferous rocks of Forfarshire and their contents: Quart. Jour. Geol. Soc., London, v. XX, p. 413–429, 1 pl.

PRANTL, F., & PŘIBYL, A., 1948, Revise Různorepých (Eurypterida) z Českého Siluru: "Rozpravy," Státního Geologického ustavu Českoslov. Rep., v. 10, 116 p., 6 pls.

PRUVOST, P., 1911, Note sur quelques crustacés (*Prestwichia*, *Belinurus* et *Eurypterus*), du terrain houiller du nord de la France: Ann. Soc. géol. Nord, v. 40, p. 295–302, pl. 7.

——, 1919, La faune continentale du terrain houiller du nord de la France: Mem., La carte géologique detaillée et la France, 584 p., 24 pls.

——, 1923, Un eurypteride nouveau du terrain houiller de Charleroi: Ann. Soc. géol. du Nord, v. 48.

——, 1939, *Eurypterus* (*Anthraconectes*) *corneti* du Westphalien A du Mons: Ann. Soc. Sci., Bruxelles, ser. 11, v. 59, p. 56–60.

PŘIBYL, A., 1953, On the genus *Adelophthalamus* Jordan and Meyer, 1854 (Eurypterida) and its representatives in the Upper Carboniferous of Czechoslovakia: "Rozpravy," II. tridy České Akad., v. 53, no. 2, 17 p., 2 pls.

RAW, F., 1957, Origin of Chelicerates: Jour. Paleontology, v. 31, no. 1, p. 139–192.

REUSS, A. E., 1855, Ueber eine neue Krusterspecies aus der böhmischen Steinkohlenformation: Denkschr. K.-K. Akad., Wiss., Wien, v. 10, p. 81–83, pls. 3–4.

ROEMER, F., 1851, Ueber ein bisher nicht beschriebenes Exemplar von *Eurypterus*, aus devonischen Schichten des Staats New York, in Nord-Amerika: Palaeontographica, v. 1, p. 190, pl. 27.

——, 1856, *in* H. G. BRONN's Lethaea geognostica, über Abbildungen und Beschreibungen der für die Gebirgsformationen bezeichnendsten Versteinerungen, 3rd ed., Stuttgart.

——, 1873, Notiz über das Vorkommen von *Eurypterus Scouleri* im niederschlesichen Steinkohlengebirge: Zeitschr. d.d. Geol. Ges., v. 35, p. 562–565.

RUEDEMANN, R., 1912, The Lower Silurian shales of the Mohawk Valley: N. Y. State Mus., Bull., 162, 151 p., 10 pls.

——, 1925, Silurian (Ontarian) faunas: N. Y. State Mus., Bull., no. 265.

——, 1926, The Utica and Lorraine formations of New York: Pt. 2, no. 2, Mollusks, crustacean and eurypterids: N. Y. State Mus., Bull., no. 272, 227 p., 29 pls.

——, 1934, Eurypterids in graptolite shales: Am. Jour. Sci., v. 27, p. 374–385.

——, 1935, The eurypterids of Beartooth Butte, Wyoming: Am. Philos. Soc., Proc., v. 75, no. 2, p. 129–141, 4 pls.

——, 1939, Type invertebrate fossils of North America (Devonian) Eurypterida: Wagner Free Mus. Sci. (Cards).

——, 1942, Some new eurypterids from New York: N. Y. State Mus. Bull. 327, p. 24–29.

SALTER, J. W., 1855, On some new Crustacea from the uppermost Silurian rocks: Quart. Jour. Geol. Soc., London, v. 12, p. 26–34.

——, 1859, On some new species of *Eurypterus;* with notes on the distribution of species: *ibid.*, v. 15, p. 229–236.

——, 1862a, On some species of *Eurypterus* and allied forms: *ibid.*, v. 18, p. 346–347.

——, 1863, On some fossil Crustacea from the Coal Measures and Devonian rocks of British North America: *ibid.*, v. 19, p. 75–80.

——, 1863a, On some species of *Eurypterus* and allied forms: *ibid.*, v. 19, p. 81–87.

SARLE, C. J., 1905, A new eurypterid fauna from the base of the Salina of Western New York: N. Y. State Mus., Bull. no. 68, p. 1080–1108, pls. 6–26.

SAVAGE, T. E., 1916, Alexandrian rocks of northeastern Illinois and eastern Wisconsin: Bull. Geol. Soc. America, v. 27, p. 305–324, pl. 15–17.

SCHLÜTER, C., 1881, Vorlage eines der Gruppe der Merostomen angehörigen Krebses aus dem rheinischen Unterdevon: Sber. niederrh. Ges. Bonn. Verh. naturh. ver. Rheinld. Westf., v. 38, p. 210.

SCHMIDT, F., 1883, Die Crustaceenfauna der Eurypterenschichten von Rootzikull auf Oesel: Mem. Acad. Imp. de Sci., Saint Petersbourg, 7th ser., v. 31, no. 5, Miscellanea Silurica III, p. 28–88, 9 pls.

——, 1904, Ueber die neue Merostomenform *Stylonurus* (?) *Simonsoni* aus dem Obersilur von Rootzikull auf Oesel: Bull., Acad. Imp. de Sci., Saint Petersbourg, ser. 5, v. 20, no. 3, p. 199.

SCOULER, J., 1831, Description of a fossil crustaceous animal: Cheek's Edinb. Jour. Nat. Geogr. Sci., new ser., v. 3, no. 4, p. 352–354, pl. 10.

SEDGWICK, A. & MCCOY, E., 1855, British Palaeozoic rocks and fossils: with Appendix A, by J. W. Salter: Descriptions of a few spe-

cies from Wales and Westmorland referred to in the foregoing work: p. 175, p. V.

SEEMANN, F., 1906, Beiträge zur Gigantostrakenfauna Böhmens: Beitr. Paläont., Öster.-Ung., v. 19, p. 49–57, pl. 4.

SEMPER, M., 1898, Die Gigantostrake des älteren böhmischen Palaozoicums: Beitr Paläont. Österr.-Ung., v. 2, p. 71–88.

SHIMER, H. W. & SHROCK, R. R., 1944, Index fossils of North America, 837 p., 303 pls., John Wiley & Sons, New York.

STAINIER, X., 1915, On a new eurypterid from the Belgian Coal Measures: Quart. Jour. Geol. Soc., London, v. 71, p. 639–647, pl. 53.

——, 1935, Matériaux por la faune du houiller de Belgique: Bull. Soc. Belge Geol., Pal., Hydr. (Bruxelles), v. 45, p. 15–19.

STØRMER, L., 1934, Eurypterid remains from the Ludlow zone 9d (Silurian) of Ringerike: Norsk Geol. Tidssk., Bd. 14, p. 119–126.

——, 1934a, Merostomata from the Downtonian sandstone of Ringerike, Norway: Skr. Norske Videnskaps-Akad. i Oslo, I. Matem.-Naturrid, Klasse, 1933, no. 10, 125 p., 12 pls.

——, 1934b, Downtonian (Silurian) Merostomata from Spitsbergen, with remarks on the suborder Synzyshosura: K. Norske Videns,. Selskskr. 1934, Bd. 2, no. 3, 26 p., 2 pls.

——, 1934c, Über den neuen von W. Gross beschriebenen Eurypteriden aus dem Unterdevon von Overath im Rheinland: Jb. preuss. geol., L.-A., v. 55, p. 284–291.

——, 1934d, A new eurypterid from the Saaremaa (Oesel-)' beds in Esthonia: Tartu Univ., Geol. Inst. Pub., p. 244–250, 1 pl.

——, 1936, *Mixopterus dolichochelus* (Laurie M.S.), a Downtonian eurypterid from Scotland: Summary Prog. Geol. Surv. Great Britain 1934, pt. II, p. 41–46, pl. 4.

——, 1936a, Eurypteriden aus dem rheinischen Unterdevon: Preuss. Geol. Landesanst., Abh. N.F., H. 175, 74 p., 12 pls.

——, 1938, *Eurypterus fischeri* in Ludlow beds (9d) Silurian at Ringerike: Norsk Geol. Tidssk. Bd. 18, H. 1, p. 69–70.

——, 1954, New discoveries of ostracoderms and eurypterids at Ringerike, near Oslo: Proc. Geol. Soc. London, no. 1505, p. 21–22.

——, 1955, Chelicerata [*in* Part P, Arthropoda 2, Treatise on invertebrate paleontology; R. C. Moore, Ed.] Geol. Soc. America, p. P23–P41.

ŠUSTA, V., 1928, Stratigrafie ostravsko-karvinskeho kamenouhelneho reviru ve svělle Palaeontologie: I, svazek (Band)., Moravská Ostrava.

——, 1932, Přobězná zpráva o nálezu šupin a zubú sladkovodních ryb a jiňe kontínentalni fauny z vrstev karvinskych: Sborník Přírodověd, 5 pol., r VII, Moravská Ostrava.

SWARTZ, C. K., *et al.*, 1925, Silurian Volume, Md. Geol. Survey, 794 p., 67 pls.

TILTON, J. L., PROUTY, W. F., TUCKER, R. C. & PRICE, P. H., 1927, Hampshire and Hardy Counties: W. Va. Geol. Survey, 624 p.

VAN OYEN, F. H., 1956, Contribution a la connaissance du genre *Adelophthalmus* Jordan et Meyer, 1854: Med. Geol. Stichting, Ser. C-IV-3, no. 7, p. 12 pls.

VANUXEM, L., 1842, Geol. Rpt. of the Third District, New York, 306 p., 80 figs.

VĂSCĂUȚANU, T., 1932, Formatiunile Siluriene din Malul Romanesc al Nistrului (Contribuțiuni al Cunoasterea Paleozoicului din Basinul Molclo-podolic) An. Inst. geol. României, v. 15, p. 425–663, 12 pls.

WALCOTT, C. D., 1882, Notice of the discovery of a poecilopod in the Utica slate formation: Am. Jour. Sci., v. 23, no. 134, p. 151–152.

WATERLOT, G., 1953, Classe des Merostomes: *in* PIVETEAU, J., Traité de Paléontologie, v. 3, p. 529–554.

WATERSTON, C. D., 1957, The Scottish Carboniferous Eurypterida: Trans. Royal Soc. Edinb., v. 63, pt. 2, no. 12, p. 265–288, 4 pls.

WELLER, S., 1898, A bibliographic index of North American Carboniferous invertebrates: U. S. Geol. Survey Bull., no. 153, 653 p.

WHITEAVES, J. F., 1884, Palaeozoic fossils of Canada, Geol. and Nat. Hist. Survey of Canada: v. 3, pt. 1, 43 p., 8 pls.

WHITFIELD, R. P., 1882, Descriptions of new species of fossils from Ohio, with remarks on some of the geological formations in which they occur: N. J. Acad. Sci., Ann. 2, p. 193–244.

——, 1893, Contributions to the paleontology of Ohio: Ohio Geol. Survey, v. 7, p. 416–417, pl. v.

WOODWARD, H., 1864, On a nearly perfect specimen of *Eurypterus lanceolatus* (Salter) from the Upper Ludlow rock at Lesmahagow, Lanarkshire: Geol. Mag., v. 1, p. 107–114, pl. v.

——, 1868, On some new species of Crustacea from the Upper Silurian rocks of Lanarkshire and further observations on the structure of *Pterygotus:* Quart. Jour. Geol. Soc., London, v. 24, p. 289–296, 4 pls.

——, 1866–78, A Monograph of the British fossil Crustacea belonging to the order Merostomata: Palaeontogr. Soc., 263 p., 36 pls.

——, 1871, On a new species of *Eurypterus* (*El Brodiei*), from Perton, near Stoke Edith, Herefordshire: Quart. Jour. Geol. Soc., London, v. 27, p. 261–263.

——, 1871a, Trans. Woolhope Club, p. 276.

——, 1877, Catalogue of the British fossil Crustacea with their synonyms and the range in time of each genus and order: British Mus., N. H., p. 64–69.

——, 1887, On a new species of *Eurypterus* from the Lower Carboniferous shales of Glencartholm, Eskdale, Scotland: Geol. Mag., n.s., v. 4, p. 481–484, pl. 13.

——, 1907, Two new *Eurypterus* from the Coal Measures of Ilkeston, Derbyshire: *ibid.*, v. 4, p. 277–282, pl. 13

JOURNAL OF PALEONTOLOGY, V. 32, NO. 6, P. 1149–1159, 3 TEXT-FIGS., NOVEMBER 1958

PALEONTOLOGICAL NOTES

GEOLOGIC RANGE AND RELATIONSHIPS OF THE FRESHWATER SNAIL *ANISUS PATTERSONI*

DWIGHT W. TAYLOR
U. S. Geological Survey, Washington, D. C.

ABSTRACT—The freshwater snail heretofore known as *Gyraulus pattersoni* is the first late Cenozoic representative of the Old World genus *Anisus* to be recognized in America. Its known range now includes the middle Pliocene and late Pleistocene, as well as the early Pleistocene to which it was originally believed restricted.

INTRODUCTION

The freshwater planorbid snail described by Baker (1938) as *Gyraulus pattersoni* was believed for some years to be restricted to the early Pleistocene of the Great Plains. Recent collecting and study show that it has a longer range, in both the Pliocene and Pleistocene, and is one of the very few extinct nonmarine mollusks known in the late Pleistocene of North America. Furthermore, it represents the genus *Anisus*, and is the first post-Eocene record in America of this Old World genus.

This study is concerned only with the distribution of the species and revision of its taxonomic position; for illustrations and morphologic descriptions see Baker (1938) and Leonard (1950, 1957). Publication is authorized by the Director, U. S. Geological Survey.

DISCUSSION

Records of *Anisus pattersoni* show that it was a member of the North American fauna in preglacial times. Distribution of the species suggests that it may have lived in the northern and mountainous parts of the continent during nonglacial times, and moved southward during intervals of glaciation. In the High Plains *A. pattersoni* is found only in glacial-age faunas.

The relatively long range of this snail, extending into the time of last glaciation (Wisconsin), stimulates speculation as to whether it is truly extinct, or may someday be found living in the Canadian wilderness. Although knowledge of the North American nonmarine mollusks is rather sketchy about large regions, *A. pattersoni* would probably have been found alive if it were common in northern or western Canada. There are, however, several species known in Pleistocene deposits which today have restricted or sporadic distributions not yet understood. These species may be gradually dying out, or perhaps require ecologic conditions which are not widely available. *Hendersonia occulta* (Say), *Lymnaea megasoma* Say, *Physa skinneri* Taylor, *Acroloxus coloradensis* (Henderson), and *Discus macclintocki* (Baker) are such species. *Anisus pattersoni* may be similar in having a local distribution.

Only one other nonmarine mollusk known has a geologic range similar to that of *Anisus pattersoni*. The extinct slug *Deroceras aenigma* Leonard is known from the late Pliocene of Texas and Kansas, is common in the earlier and middle Pleistocene of the High Plains, and probably occurs in Wisconsin deposits in Ohio (La Rocque & Conley, 1956).

HISTORICAL REVIEW

Anisus pattersoni was described (Baker, 1938) from Brown County, Nebraska, where unnamed sediments have yielded both mammals and mollusks. The assemblage is now called the "Sand Draw local fauna," and thought to be of Nebraskan age (Hibbard, 1957, Taylor, 1954, and references therein). Later work by the Kansas Geological Survey has revealed its widespread occurrence from Nebraska to Texas in the Cudahy fauna associated with the Pearlette ash (Leonard, 1950). From this information Leonard (1950) concluded that "*Gyraulus*" *pattersoni* was restricted to this narrow interval within the Pleistocene.

Since 1950 the range of this species has been expanded to include the late Pleisto-

cene of Ohio (Leonard, 1953) and middle Pliocene of Wyoming (Taylor, 1956).

TAXONOMY

In 1938 F. C. Baker placed this species in *Gyraulus*, to which it has been referred in most subsequent publications. That Baker later intended to transfer the species from *Gyraulus* is suggested by the fact that it is not listed under that genus in his final work (Baker, 1945), although neither is it mentioned elsewhere in that work.

"*Gyraulus*" *pattersoni* agrees with *Anisus* and differs from *Gyraulus* in the following characters: numerous whorls, up to 5½ (the maximum number in *Gyraulus* is four); very slowly and regularly enlarging whorls (more rapidly enlarging in *Gyraulus*); almost plane sides, especially the left side (*Gyraulus* has convex whorls, and usually a concave left and convex right side); and quadrangular aperture (ovate in *Gyraulus*).

The species most similar to *A. pattersoni* is *A. rotundatus* (Poiret), discussed by Germain (1931) and Geyer (1927). The only difference in shells between the two is apparently one of size. *A. rotundatus* has six to seven whorls, whereas no specimens of *A. pattersoni* with more than five and a half whorls have been seen. *A. rotundatus* is larger, even in specimens with similar numbers of whorls, and attains the diameter of 8 mm. as compared to a maximum of 4.6 mm. seen in *A. pattersoni*.

One of the characters emphasized by Germain (1931) for *A. rotundatus* is the presence of an apertural callus. The presence of such a callus in *A. pattersoni* is another feature relating it to *A. rotundatus*, along with the characters of size, shape, and sculpture.

ECOLOGY

Since *Anisus pattersoni* is an extinct species, its habitat preferences cannot be learned in detail. Some information, however, may be gained from the associated shells referred to living species, and from its relative *A. rotundatus*.

A. pattersoni is known primarily from the Pleistocene of the Great Plains, although there are now a number of additional records. Its occurrences in this area suggest that it lived in shallow, quiet waters, in the backwaters along a stream or in semipermanent ponds and sloughs. The habitat may have been like that of *Gyraulus circumstriatus*, which lives in such situations, particularly if the apertural callus shared by these two snails is an adaptive character correlated with resistance to desiccation of the ponds they inhabited.

Concerning the habitat of *Anisus rotundatus* in France, Germain (1931) wrote (translation):

"It lives in ditches, ponds, swamps, preferably standing and slightly muddy waters; sometimes it buries itself rather deeply in the mud; less abundant in clear waters. A species of the plains regions, very common in the west and southwest, less common in the other parts of France."

Its habitat in Germany was summarized by Kreglinger (1870), thus (translation):

"Prefers clear, gently flowing or quiet water with a thick growth of *Chara*, *Riccia*, *Lemna* and confervae. If the waters dry up in persistent dry weather, it retreats among the decaying leaves on the bottom; and if finally these too become dry, it protects itself against desiccation by sealing its shell with a white, papery lid."

RANGE

Anisus pattersoni is now known from the middle Pliocene to late Pleistocene (Wisconsin age), and from Idaho and Ohio to northern Texas. The precise localities are indicated below; sources of information are either the publications mentioned, or examination of the specimens cited.

Names of institutions are abbreviated as follows: A.N.S.P., Academy of Natural Sciences of Philadelphia; C.N.H.M., Chicago Natural History Museum; U.I.M.N.H. University of Illinois Museum of Natural History; U.M.M.Z., University of Michigan Museum of Zoology; U.S.G.S., United States Geological Survey; U.S.N.M., United States National Museum.

Middle Pliocene.—Lincoln Co., Wyoming. Afton quadrangle (1921) 1:125000. (U.S.G.S. Cenozoic locality 19180), SE¼ NE¼ sec. 13, T. 33 N., R. 119 W. Teewinot formation. Old mine entry on south side of Willow Creek valley. E. M. Parks and C. S. Lavington, 1923.

Several localities in the Teewinot formation in Grand Valley and Star Valley,

Idaho-Wyoming, have yielded fossil mollusks (Merritt, 1956; Taylor, 1956), but *Anisus pattersoni* is known from only one. The age of the formation is determined partly by mammals found in Grand Valley, partly by correlation with the mammal-dated Teewinot formation in Jackson Hole, Wyoming (Love, 1956). *Material:* U.S.G.S. 19180–5 (22 specimens), U.S.N.M. 563095 (1 figured specimen, Taylor, 1956, p. 124, fig. 1). All shells are somewhat crushed, but are adequate to show clearly the diagnostic shape, small size, many closely coiled whorls, and sculpture of fine growth lines.

Late Pliocene.—Owyhee Co., Idaho. Hammett quadrangle (1948) 1:24000. (U.S.G.S. Cenozoic locality 19128), SW¼ sec. 1, T. 6 S., R. 8 E. 1550′ E. and 650′–1050′ N. of SW corner. 2600′ elev. Unnamed formation; Sand Point local fauna. Sandy coquina weathering on lower slopes of cliff on south side Snake River. D. W. Taylor, 1956.

Many localities in the Glenns Ferry area in this late Pliocene unit have yielded mollusks, but these nearly all represent a deeper-water lacustrine or fluviatile facies. It is not surprising, therefore, that *Anisus pattersoni* and other mollusks of shallow, standing water habitats are rather rare. The age of the formation is indicated by the mammals (Hibbard, in press), mollusks, and stratigraphic sequence under study by Malde and Taylor. *Material*: U.S.G.S 19128 (1 specimen).

Cache Co., Utah. (U.S.G.S. Cenozoic locality 20093), sec. 15, T. 13 N., R. 2 W. Cache Valley formation. Pebbly oölite and oölite weathering on the western side of the crest of the Junction Hills, on the boundary between Cache and Box Elder counties, Utah. D. W. Taylor, 1956.

Fossils from this locality were first recorded by Yen (1947); subsequently Adamson, Hardy & Williams (1955) have described the stratigraphy. The age of the molluscan assemblage is probably late Pliocene because of its greater resemblance to established late Pliocene assemblages in southern Idaho than to older faunas (Taylor, in preparation). *Material:* U.S.G.S. 20093–15 (2 specimens).

Early Pleistocene.—Twin Falls Co., Idaho. Hagerman quadrangle (1950) 1:24000 (U.S.G.S. Cenozoic locality 19204), NW¼ sec. 3, T. 8 S., R. 13 E. 1600′ E., 1700′–1900′ S. of NW corner. 2835′ elev. Hagerman formation. Clay and silt exposed in cliff face behind boathouse. D. W. Taylor, 1955. *Material:* U.S.G.S. 19204–15, 10 specimens.

Brown Co., Nebraska; Sand Draw local fauna. Fossils from this assemblage have been recorded by Baker (1938), McGrew (1944), Taylor (1954), and Hibbard (1957). The assemblage is from an unnamed formation, and is considered of late Nebraskan age on the basis of the stratigraphic indications of the mammals and mollusks, and the environmental interpretation of the mollusks.

Locality 2 (U.S.G.S. Cenozoic locality 19090), NW¼ sec. 14, T. 31 N., R. 23 W. Exposures at head of West Fork of Deep Creek. Sandy layer in thin-bedded sand and clay about 38′ below top of formation.

Locality 3, NE¼ SW¼ sec. 12, T. 31 N., R. 23 W. Exposure on east side of Middle Fork of Deep Creek. Thin-bedded sand and clay, 35′–40′ below top of formation.

Locality 4, NW¼ sec. 33, T. 31 N., R. 22 W. Exposure on north side of Sand Draw. Marly silt, 21′–22′ below top of formation.

Locality 5, center of north side sec. 34 and SE corner SW¼ sec. 27, T. 31 N., R. 22 W. Exposures on small draw near earth dam. Marly silt, 18′–20′ below top of formation. Mollusks from this locality were listed by McGrew (1944) as "from an exposure two miles west of Sand Draw." Baker (1938) reported the snails by error as from the exposure on Sand Draw (see below).

Locality 6 (U.S.G.S. Cenozoic locality 19091), north side of SW¼ and south side of NW¼, sec. 25, T. 31 N., R. 22 W. Exposures along first wash south of Sand Draw on state highway 7. Marly sand and tan silt, 8′–15′ below top of formation. Mollusks from this locality were listed by McGrew (1944) as from the "Sand Draw exposure," and by Baker (1938) by error (see below) as from two miles west of the Sand Draw exposure.

Locality 7, near center of SW¼ SE¼ sec. 4, T. 30 N., R. 21 W. Exposure on Bone Creek near *Stegomastodon* quarry. Baker (1938) listed mollusks from two localities, one "six miles north of Ainsworth" and the

other "about two miles west" of the former. Bryon Patterson, who collected the material, stated in a letter (December 22, 1949) to C. W. Hibbard that Baker transposed the two localities. A letter from Baker to Patterson clearly shows that this transposition took place. McGrew (1944) corrected the error, but without so indicating. *Material from Sand Draw local fauna:* Locality 2 U.S.G.S. 19090–1, (6 specimens); locality 3, U.M.M.Z. 177332 (150 specimens); locality 4, U.M.M.Z. 177316 (6 specimens); locality 5, C.N.H.M. P26128 (1, the holotype), P26129 (2 paratypes), A.N.S.P. 169948 (2 paratypes), U.I.M.N.H. P7455 (4 paratypes); locality 6, U.M.M.Z. 177427 (48 specimens), 181211 (500 specimens); locality 7, U.M.M.Z. 177231 (75 specimens).

Kingman Co., Kansas. Dixon local fauna locality 1, S½ sec. 12, T. 29 S., R. 8 W. An equivalent of, or part of, the Missler member of the Ballard formation. Fossils from this locality include several groups of vertebrates and mollusks (Hibbard 1956, and references therein). The fauna is believed to be of transitional Nebraskan-Aftonian age on the basis of combined evidence of stratigraphic restriction and environmental interpretation. *Material:* U.M.M.Z. 182199 (26 specimens).

Middle Pleistocene.—Cudahy fauna, late Kansan age, central Great Plains region. Leonard (1950) and Frye & Leonard (1952) have recorded *Anisus pattersoni* from a number of localities associated with the Pearlette ash in Iowa, Nebraska, Kansas, Oklahoma, and Texas. The late glacial age of this assemblage is most clearly evident in Meade County, Kansas. Here the Cudahy fauna with its markedly northern elements stands in striking contrast to the interglacial Borchers local fauna only a few feet higher in a conformable section (Hibbard 1944, 1949).

Late Pleistocene.—Meade Co., Kansas. Butler Spring local fauna locality 1, SE¼ SE¼ sec. 32, T. 34 S., R. 29 W. Sanborn group, undifferentiated. The fauna (Hibbard & Taylor, in preparation) is considered of late Illinoian age on the basis of ecologic interpretations and stratigraphic succession. *Material:* U.M.M.Z. uncat. (33 specimens).

Cuyahoga Co., Ohio. Leonard (1953) recorded *Anisus pattersoni* from early Wisconsin (Farmdale?) loess in Cleveland.

REFERENCES

ADAMSON, R. D., HARDY, C. T., & WILLIAMS, J. S., 1955, Tertiary rocks of Cache Valley, Utah and Idaho: Utah Geol. Soc. Guidebook 10, p. 1–22.

BAKER, F. C., 1938, New land and freshwater Mollusca from the upper Pliocene of Kansas and a new species of *Gyraulus* from early Pleistocene strata: Nautilus, v. 51, p. 126–131.

——, 1945, The molluscan family Planorbidae: Univ. Illinois Press, xxxvi, 530 p.

FRYE, J. C., & LEONARD, A. B., 1952, Pleistocene geology of Kansas: Kansas Geol. Survey Bull. 99, 230 p., 19 pls.

GERMAIN, LOUIS, 1931, Mollusques terrestres et fluviatiles (deuxième partie): Faune de France, v. 22, p. 479–897, i–xiv, pls. 14–26.

GEYER, DAVID, 1927, Unsere Land- und Süsswasser-mollusken; Einführung in die Molluskenfauna Deutschlands, ed. 3: Stuttgart (K. G. Lutz), 224 p., 33 pls.

HIBBARD, C. W., 1944, Stratigraphy and vertebrate paleontology of Pleistocene deposits of southwestern Kansas: Geol. Soc. America Bull., v. 55, p. 707–754, 3 pls.

——, 1949, Pleistocene stratigraphy and paleontology of Meade County, Kansas: Mich. Univ. Mus. Paleont. Contrib., v. 7, p. 63–90, 1 pl.

——, 1956, Vertebrate fossils from the Meade formation of southwestern Kansas: Mich. Acad. Sci. Papers, v. 41, p. 145–200. 2 pls.

——, 1957, Two new Cenozoic microtine rodents: Jour. Mammalogy, v. 38, p. 39–44.

——, 1959, Late Cenozoic microtine rodents from Wyoming and Idaho: Mich. Acad. Sci. Papers (in press).

KREGLINGER, CARL, 1870, Systematisches Verzeichniss der in Deutschland lebenden Binnen-Mollusken: Wiesbaden (C. W. Kreidel). xxviii, 402 p.

LA ROCQUE, AURÈLE, & CONLEY, J. F., 1956, Two Pleistocene molluscan faunules from Hunter's Run, Fairfield County, Ohio: Ohio Jour. Sci., v. 56, p. 325–328.

LEONARD, A. B., 1950, A Yarmouthian molluscan fauna in the midcontinent region of the United States: Kans. Univ. Paleont. Contrib. 8, 48 p., 6 pls.

——, 1953, Molluscan faunules in Wisconsinan loess at Cleveland, Ohio: Am. Jour. Sci., v. 251, p. 369–376, 1 pl.

——, 1957, Types of Late Cenozoic gastropods in the Frank Collins Baker Collection, Illinois State Geological Survey: Illinois Geol. Survey Rept. Inv. 201, 23 p., 4 pls.

LOVE, J. D., 1956, Cretaceous and Tertiary stratigraphy of the Jackson Hole area, northwestern Wyoming: Wyo. Geol. Assoc. Guidebook 11, p. 76–94, map.

MCGREW, P. O., 1944, An early Pleistocene (Blancan) fauna from Nebraska: Field Mus. Nat. Hist. Geol. Ser., v. 9, p. 33–66.

MERRITT, Z. S., 1956, Upper Tertiary sedi-

mentary rocks of the Alpine, Idaho-Wyoming area: Wyo. Geol. Assoc. Guidebook 11, p. 117–119.

TAYLOR, D. W., 1954, A new Pleistocene fauna and new species of fossil snails from the High Plains: Mich. Univ. Mus. Zool. Occas. Papers 557, 16 p.

——, 1956, Pliocene mollusks from Jackson Hole, Grand Valley, and Star Valley, Wyoming and Idaho: Wyo. Geol. Assoc. Guidebook 11, p. 123–125.

YEN, TENG-CHIEN, 1947, Pliocene fresh-water mollusks from northern Utah: Jour. Paleontology, v. 21, p. 268–277.

A NEW CRETACEOUS CRIBRIMORPH BRYOZOAN FROM LOUISIANA

E. ANN BUTLER AND ALAN CHEETHAM
Louisiana Geological Survey and Louisiana State University

ABSTRACT—*Rhiniopora spooneri*, n. sp., from Upper Cretaceous rocks exposed at Rayburns dome, Bienville Parish, Louisiana, is the first representative of *Rhiniopora* reported from the North American Cretaceous. The genus is common in Campanian and Maestrichtian deposits in Europe.

INTRODUCTION

Although cheilostome Bryozoa have been described extensively from rocks of Cretaceous age in Europe, they are but poorly known in rocks of equivalent stratigraphic position in North America (Cheetham, 1954). An important genus in the European Upper Cretaceous is the cribrimorph *Rhiniopora* Lang, which occurs in Campanian and Maestrichtian deposits in Britain, Germany, Holland, and France (Table 1). Heretofore, *Rhiniopora* has been known from North America only from two species that occur in the Vincentown marl of New Jersey (Canu & Bassler, 1933, p. 53,54), now generally considered to be Paleocene (Loeblich & Tappan, 1957, p. 1131).

The specimens of *Rhiniopora spooneri*, n. sp., on which the present study is based, are from a chalk bed exposed at Rayburns dome, Bienville Parish, Louisiana (SW¼ NE¼ sec. 31, T. 15 N., R. 5 W.). The holotype was collected in connection with an investigation of Louisiana Cretaceous ostracods (Butler & Jones, 1957); the paratype had been collected earlier from the same locality by W. C. Spooner and had been placed, unidentified, in the L. S. U. Geology Museum. We are indebted to Dr. H. V. Andersen, Curator, for allowing us to use this specimen in the study.

Evaluation of stratigraphic ranges of the ostracods has indicated that the chalk bed is equivalent to the Upper Cretaceous Saratoga chalk of Arkansas (Butler & Jones, 1957, p. 3). The bryozoans incrust interiors of valves of *Ostrea vesicularis* and *Inoceramus*.

The report is published with permission of the State Geologist, Louisiana Geological Survey. Authors are listed in alphabetical order, no seniority implied.

TABLE 1—STRATIGRAPHIC RANGES OF EUROPEAN SPECIES OF *Rhiniopora* (COMPILED FROM LANG, 1922, AND VOIGT, 1930)

	Campanian				Maestrichtian	
	Britain	Germany	Holland	France	Germany	Holland
R. asperula (Marsson)	X	X				
R. cacus (Brydone)	X	X	—	—	X	
R. hispida Lang	—	X				
R. horrida Lang	—	X				
R. scabra Lang	—	X				
R. faujasi (Hagenow)	—	—	X			
R. radiata (d'Orbigny)	—	—	—	X		
R. jurassica (Gregory)	—	—	—	—	—	X
R. aviculosa Lang	—	—	—	—	—	X
R. labiata (Levinsen)	—	—	—	—	—	X

EVOLUTION IN *Rhiniopora*

The known species of *Rhiniopora* constitute two groups. The *R. aviculosa* group ("lineage I" of Lang, 1922, p. 182,183), which includes *R. labiata*, is characterized by numerous, dimorphic avicularia. The *R. asperula* group ("lineage II" of Lang) comprises the other eight species listed in Table 1 and is characterized by few, monomorphic avicularia or no avicularia at all. *R. tubulosa* and *R. parvirostrata* of Canu & Bassler probably should be added to the latter group. Evolutionary tendencies in the *R. asperula* group are shown in Table 2.

R. spooneri appears to be the most primitive species in the *R. asperula* group in every character. If *R. spooneri* is indeed ancentral to the European species of *Rhiniopora*, the Saratoga chalk of Arkansas, long considered to be Maestrichtian (Stephenson *et al.*, 1942, pl. 1), may be older, i.e., Campanian; or *R. spooneri* may have persisted in America from Campanian to Maestrichtian and should be sought in rocks underlying the Saratoga.

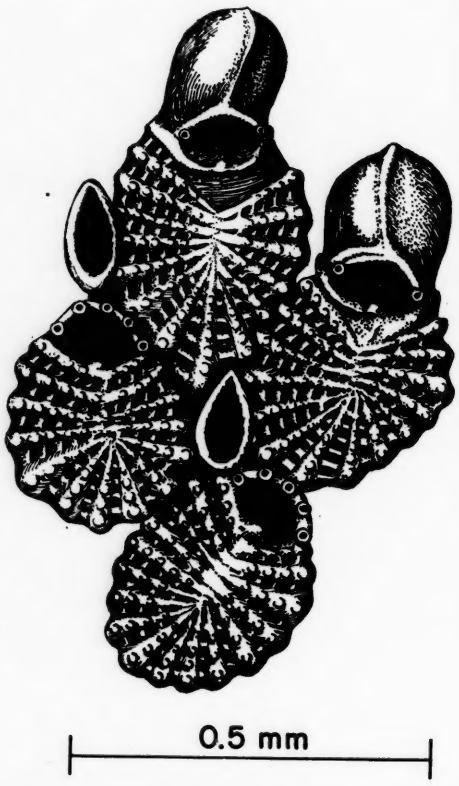
SYSTEMATICS

Order CHEILOSTOMATA Busk, 1852
Suborder CRIBRIMORPHA Lang, 1916
Family PELMATOPORIDAE Lang, 1916
Subfamily CASTANOPORINAE Lang, 1916
Genus RHINIOPORA Lang, 1916

RHINIOPORA SPOONERI, n. sp.

Text-figs. 1–3

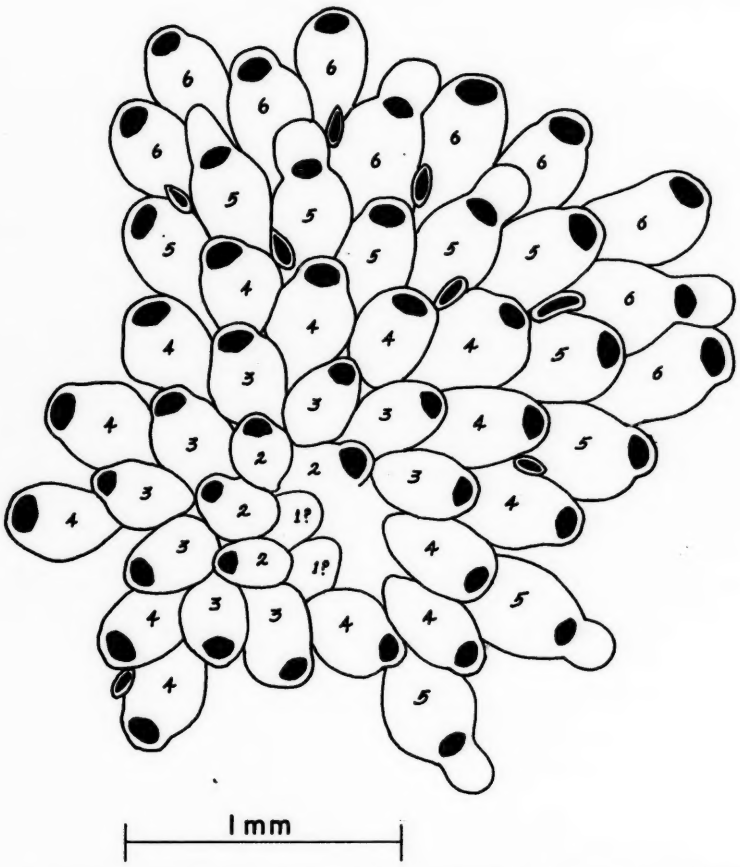
Diagnosis.—*Rhiniopora* having membraniporiform zoaria, rhomboidal zooecia, semicircular to cribriline orifices (Text-fig. 3), and moderately numerous, monomorphic, distally directed avicularia. Autozooecial orifices each with five distal spines. Differs from *R. asperula* (Marsson), its closest relative, in size of autozooecia, number of costulae, and orientation of avicularia.



TEXT-FIG. 1—*Rhiniopora spooneri*, n. sp. Two fourth-generation autozooecia, two fifth-generation ovicelled zooecia, and two avicularia. Holotype no. 1390.

TABLE 2—EVOLUTION IN THE *Rhiniopora asperula* GROUP (COMPILED FROM LANG, 1922)

Character	Primitive Species	Advanced Species
Avicularia	Present	Absent
Autozooecia	Small (Lz 0.30–1.00 mm. for mature zooecia)	Large (Lz 1.00–1.70 mm. for mature zooecia)
Costulae	Few (14–20 per zooecium)	Numerous (20–30 per zooecium)
Lacunae	Few (5–6 between each pair of costulae)	Numerous (6–8 between each pair of costulae)
Pelmatidia	Few (4–6 per costula)	Numerous (6–8 per costula)
Shape of Orifice	Highly variable (subsemicircular to supernormal)	Less variable (subnormal to supernormal)



TEXT-FIG. 2—*Rhiniopora spooneri*, n. sp. Astogeny in holotype no. 1390.

Description.—Zoaria membraniporiform, incrusting interiors of valves of *Ostrea* and *Inoceramus*, composed of zooecia in radiating rows, those in adjacent rows alternating in position; number of zooecial rows increases distally by bifurcation or trifurcation. Thirty-eight autozooecia, eight ovicelled zooecia, and seven avicularia in larger zoarial fragment (holotype).

Ancestrula not preserved in specimens studied; first generation blastozooecia represented by lateral walls only. Blastozooecia of first three generations progressively larger, those of fourth and succeeding generations

TABLE 3—VARIATION IN SIZE (MM.) AND COSTULATION IN HOLOTYPE OF *R. spooneri*

Generation	Length of Zooecium (Lz)				Width of Zooecium (lz)				Number of Costulae			
	N	$\overline{X}$	s	O.R.	N	$\overline{X}$	s	O.R.	N	$\overline{X}$	s	O.R.
1	2	0.21	0.014	0.20–0.22	2	0.15	0.014	0.14–0.16	—	—	—	—
2	4	0.24	0.026	0.22–0.28	4	0.18	0.020	0.15–0.20	3	15	2.3	14–18
3	9	0.27	0.016	0.25–0.29	9	0.21	0.029	0.18–0.26	9	15	1.4	14–18
4	15	0.31	0.024	0.26–0.34	15	0.23	0.016	0.22–0.27	11	16	1.5	14–18
5	10	0.30	0.028	0.26–0.34	10	0.23	0.034	0.17–0.27	10	17	1.9	14–20
6	5	0.31	0.032	0.26–0.34	5	0.22	0.001	0.22–0.23	4	17	1.2	16–18

TABLE 4—FREQUENCY VARIATION (NUMBER OF ZOOECIA) IN SHAPE OF ORIFICE IN HOLOTYPE OF *R. spooneri*

	Generation				
	2	3	4	5	6
Semicircular	—	1	2	5	1
Super-semicircular	—	2	4	4	2
Subnormal	3	5	4	1	2
Normal	1	—	—	—	—
Cribriline	—	1	1	—	—

of nearly constant size (Table 3). Zooecia rhomboidal, rounded distally, about three-fourths as wide as long. Zooecial borders deeply incised; gymnocyst lacking. Frontal shield moderately convex, composed of eight or nine pairs of costulae, rarely of seven or ten pairs (Table 3). Apertural bar curved, usually mucronate. Adjacent costulae separated by four to six evenly spaced lacunae; each costula ornamented with four to six inconspicuous pelmatidia.

Orifices semicircular to cribriline (Table 4), tending to be subnormal in immature zooecia, semicircular in mature zooecia. Distal margins strongly arched, proximal margins gently arched or straight. Distal margins of autozooecial orifices bear five hollow spines; lateral margins of ovicelled zooecia bear two spines.

Ovicells hyperstomial, only slightly imbedded in distally adjacent zooecia, bulbous, somewhat elongate, smooth; median longitudinal ridge feebly developed. Ovicells occur in fifth and sixth generations of blastozooecia of holotype.

Avicularia drop-shaped, rostral end oriented distally, lacking mandibular crossbar or condyles, randomly spaced in zoarium, but not occurring among first three generations of blastozooecia.

Measurements.—Quantitative characters of mature zooecia of the holotype are shown in Table 5.

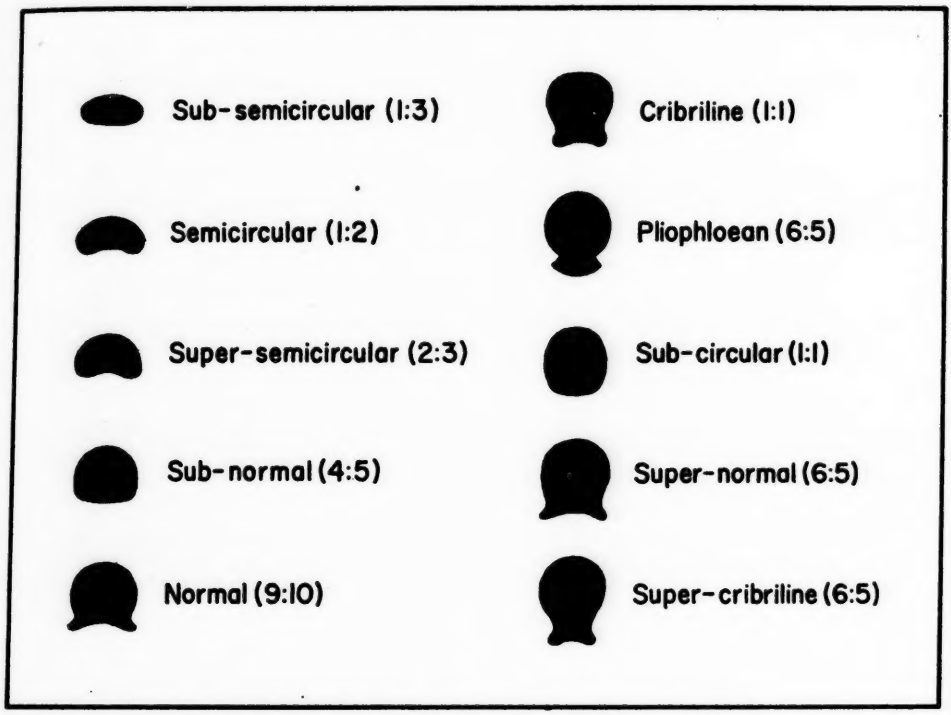
Types.—L. S. U. Geology Museum, holotype no. 1390, paratype no. 1391.

Discussion.—A comprehensive study of *Rhiniopora cacus* (Brydone) from the Maestrichtian of Germany was made by Illies (1953). This species has larger zooecia (mean Lz, 1.22 mm.; mean lz, 0.91 mm.) than *R. spooneri;* the standard deviation for length (0.11 mm.) is nine percent of the mean length, and the standard deviation for width (0.12 mm.) is 13 percent of the mean width. In *R. spooneri* the standard deviations are nine percent and ten percent of the mean length and width, respectively. *R. spooneri* differs from *R. cacus,* however, in having achieved relatively constant size of zooecia in the fourth generation instead of the fifth. *Wilbertopora mutabilis* Cheetham, another incrusting cheilostome from the Cretaceous, displays constant size in the fifth and succeeding generations like *R. cacus. R. spooneri* resembles *W. mutabilis* in having its first ovicelled zooecia in the fifth generation. Avicularia in *R. spooneri* occur in the fourth and succeeding generations, however.

The paratype of *R. spooneri* has slightly

TABLE 5—CHARACTERS OF MATURE ZOOECIA (FOURTH-SIXTH GENERATIONS) OF HOLOTYPE OF *R. spooneri*

	N	$\overline{X}$	s	O.R.
Length of zooecium (Lz)	30	0.30 mm.	0.026 mm.	0.26–0.34 mm.
Width of zooecium (lz)	30	0.23 mm.	0.024 mm.	0.17–0.27 mm.
Height of orifice (ho)	26	0.05 mm.	0.010 mm.	0.04–0.07 mm.
Width of orifice (lo)	26	0.08 mm.	0.010 mm.	0.06–0.09 mm.
Number of costulae	25	17	1.5	14–20
Length of avicularium (Lav)	8	0.13 mm.	0.020 mm.	0.11–0.15 mm.
Length of ovicell (Lov)	7	0.13 mm.	0.014 mm.	0.11–0.15 mm.



TEXT-FIG. 3—Shape of primary orifices in *Rhiniopora*. Terminology from Lang (1921); ratios (height:width) from Illies (1953).

larger zooecia (mean Lz, 0.34 mm.; mean lz, 0.25 mm.) and more numerous costulae (mean, 18 per zooecium) than the holotype. The ancestrular region is not perserved, the characteristics having been calculated from ten mature zooecia, of which four bear ovicells.

LITERATURE CITED

BASSLER, R. S., 1953, Bryozoa: Treatise Invert. Paleontology, pt. G, Univ. Kansas Press and Geol. Soc. America, 203 p.

BUTLER, E. A., & JONES, D. E., 1957, Cretaceous Ostracoda of Prothro and Rayburns salt domes, Bienville Parish, Louisiana: La. Geol. Survey, Bull. 32, 65 p., 6 pls.

CANU, FERDINAND, & BASSLER, R. S., 1933, The Bryozoan fauna of the Vincentown limesand: U. S. Natl. Mus. Bull. 165, 102 p., 21 pls.

CHEETHAM, ALAN, 1954, A new Early Cretaceous cheilostome bryzoan from Texas: Jour. Paleontology, v. 28, p. 177–184, pl. 20.

ILLIES, GISELLA, 1953, Variationsstatistische Untersuchungen an *Rhiniopora cacus* (Brydone) (Bryozoa Cheilostomata) aus der Oberkreide vom Hemmoor, Niederelbe: Hamburg min.-geol. Staatinst. Mitt., Heft 22, p. 76–100, pls. 15,16.

LANG, W. D., 1921, Catalogue of the fossil Bryozoa (Polyzoa) in the Department of Geology, British Museum (Natural History), the cribrimorphs, pt. 1: Brit. Mus. (Nat. History), 267 p., 8 pls.

——, 1922, Catalogue of the fossil Bryzoa (Polyzoa) in the Department of Geology, British Museum (Natural History), the cribrimorphs, pt. 2: Brith. Mus. (Nat. History), 403 p., 8 pls.

LOEBLICH, A. R., & TAPPAN, HELEN, 1957, Correlation of the Gulf and Atlantic Coastal Plain Paleocene and lower Eocene formations by means of planktonic Foraminifera: Jour. Paleontology, v. 31, p. 1109–1137.

STEPHENSON, L. W., KING, P. B., MONROE, W. H., & IMLAY, R. W., 1942, Correlation of the outcropping Cretaceous formations of the Atlantic and Gulf Coastal Plain and Trans-Pecos Texas: Geol. Soc. America Bull., v. 53, p. 435–448, 1 pl.

VOIGT, ERHARDT, 1930, Morphologische und stratigraphische Untersuchungen über die Bryozoenfauna der oberen Kreide: Leopoldina, Band 6, p. 379–579, pls. 36–74.

THE CONODONT HOMEOMORPHS *TAPHROGNATHUS* AND *STREPTOGNATHODUS*

CARL B. REXROAD
Illinois State Geological Survey, Urbana

When Branson & Mehl proposed the new genus *Taphrognathus* in 1940, they stated that little could be offered to separate it from *Streptognathodus* Stauffer & Plummer (1932) except that the two appeared to originate at entirely different times. In fact descriptions of the two differ only in indicating that *Streptognathodus* may have nodes arising from a shelf-like process near the base of the anterior end of the platform. However, these nodes are lacking in a number of species of *Streptognathodus*, and since such forms cannot be differentiated from the taphrognathids, the question of whether the genera are synonyms or homeomorphs must be resolved.

In 1940 two important facts for determining possible homeomorphy, the stratigraphic occurrences and phylogenetic relationships of the two genera, were not known. Subsequent study of units between the Keokuk Formation (Valmeyer Series) and early Pennsylvanian formations have clarified these two points and have demonstrated homeomorphy by more precisely delimiting the range of each genus and by showing the stock from which *Streptognathodus* developed.

The oldest known occurrence of *Taphrognathus* is in the Keokuk Formation, from which the genus originally was described, and it ranges upward into the St. Louis. It does not continue into the Ste. Genevieve Formation, nor is it present in the Chester Series, as shown by detailed studies in the type area (Rexroad, 1957) and the Illinois Basin (Rexroad, 1958). Moreover, *Taphrognathus* has not been recorded in other described faunas from rocks of this general age (Bischoff, 1957; Branson and Mehl, 1940; Elias, 1956; Flügel and Ziegler, 1957; Hass, 1950, 1953; Scott, 1942; Youngquist and Miller, 1949).

Streptognathodus, long considered to have first appeared in early Pennsylvanian, has been recorded by Elias (1956, p. 20) in the upper part of the Sand Branch member of the Caney shale, which he considers upper Chester in age by correlation with the Lower Namurian *Eumorphoceras* zone of Europe. In southern Illinois the first appearance of *Streptognathodus* is in beds of Chester age above the upper massive limestone of the Kinkaid Formation, the uppermost formation of the standard Chester sequence. Specimens from these beds described by Cooper (1947, p. 92) as *Taphrognathus varians* Branson & Mehl have been examined by the writer and are referable to *Streptognathodus*. It seems likely that the conodont-bearing lentil of the upper Sand Branch is somewhat younger than the Illinois beds, but both of these occurrences leave a wide stratigraphic gap between the ranges of *Taphrognathus* and *Streptognathodus*.

Branson & Mehl (1940a, p. 182) believed that *Cavusgnathus* developed from *Taphrognathus*, and faunas from the Mississippi Valley appear to confirm this. Transitional forms are found in the lower part of the St. Louis Formation and *Cavusgnathus* became well established during St. Louis time. In turn, in the uppermost Chester of southern Illinois specimens transitional between *Cavusgnathus* and *Streptognathodus* are found, and one well defined group of streptognathodids still retains the prominent denticle at the posterior end of the blade that is so characteristic of *Cavusgnathus unicornis* Youngquist & Miller, an abundant species in the Chester Series.

In summary, *Taphrognathus* is limited to the Valmeyer Series, while *Streptognathodus* ranges upward from the uppermost part of the Chester Series. *Cavusgnathus* developed from *Taphrognathus* during late Valmeyer time and in turn gave rise to the early species of *Streptognathodus*, a genus homeomorphic with *Taphrognathus*. Such cases of homeomorphy among conodonts probably are numerous, and their recognition will aid greatly in stratigraphic interpretation.

Publication authorized by the Chief, Illinois State Geological Survey.

REFERENCES

BISCHOFF, GÜNTER, 1957, Die Conodonten-Stratigraphie des rheno-herzynischen Unterkarbons: Hess. Landesamt. Bodenf., Abhl., Hf. 19, p. 1–64, pls. 1–6.

BRANSON, E. B. & MEHL, M. G., 1940, Caney Conodonts of Upper Mississippian age: Denison Univ. Bull., Jour. Sci. Labs., v. XXXV, p. 167–178, pl. V.

——, 1940a, Conodonts from the Keokuk Formation: *ibid*, p. 179–188, pl. VI.

COOPER, CHALMER L., 1947, Upper Kinkaid (Mississippian) Microfauna from Johnson County, Illinois: Jour. Paleontology, v. 21, p. 81–94, pls. 19–23; reprinted as Illinois Geol. Survey Rept. Inv. 122.

ELIAS, M. K., 1956, Upper Mississippian and Lower Pennsylvanian formations of south-central Oklahoma: Petroleum Geology Southern Okla., v. 1, p. 56–134, pls. 1–6 (*Published by* Am. Assoc. Petroleum Geologists).

FLÜGEL, VON, HELMUT, & ZIEGLER, WILLI, 1957, Die Gliederung des Oberdevons und Unterkarbons am Steinberg westlich von Graz mit conodonten: Naturwissenschaft. vereines f. Steiermark, Mitteil. Bd. p. 25–60, pls. 1–5.

HASS, WILBERT H., 1950, Age of lower part of Stanley Shale: Am. Assoc. Petroleum Geologists Bull., v. 34, no. 7, p. 1578–1584.

——, 1953, Conodonts of the Barnett Formation of Texas: U. S. Geol. Survey Prof. Paper 243-F, p. 69–94; pls. 14–16.

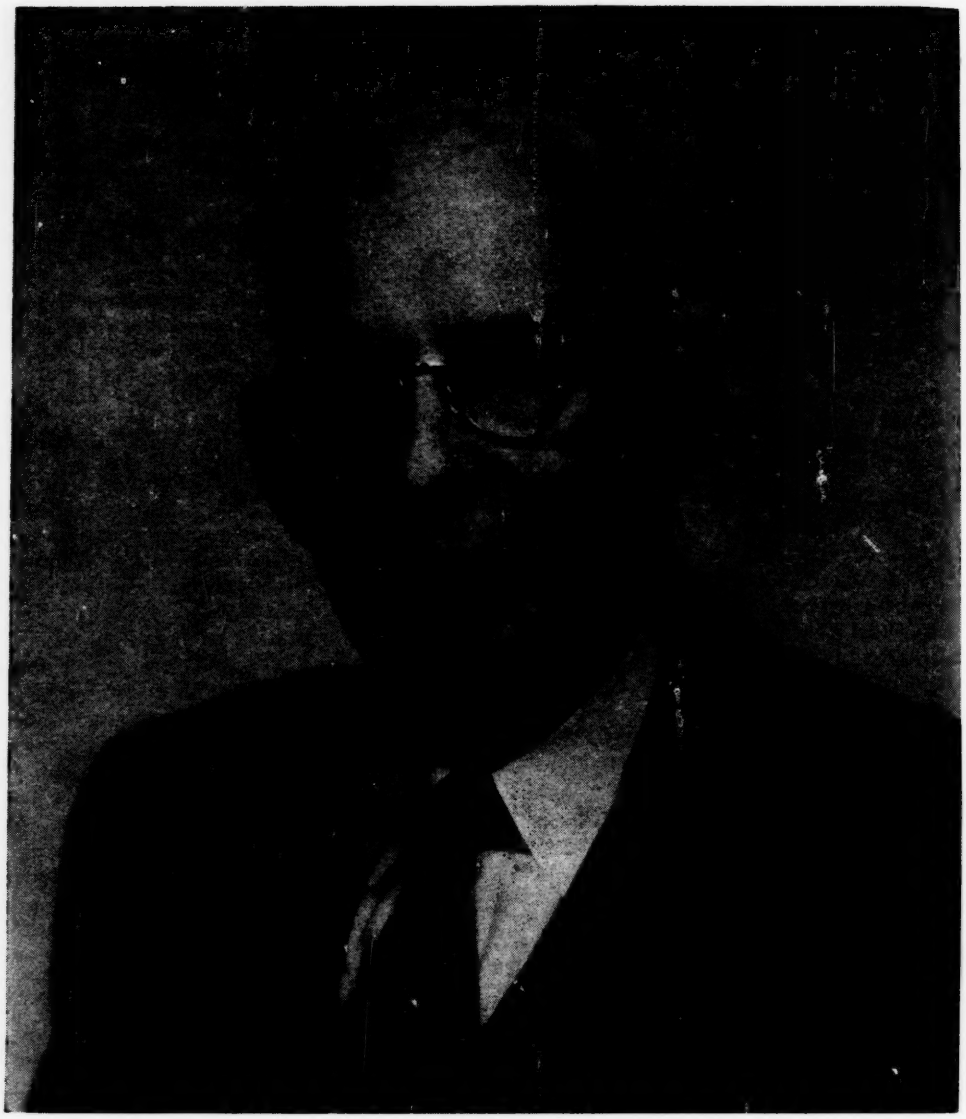
REXROAD, CARL B., 1957, Conodonts from the Chester Series in the type area of southwestern Illinois: Illinois Geol. Survey Rept. Inv. 199, p. 1–43, pls. 1–4.

——, 1958, Conodonts from the Glen Dean Formation (Chester) of the Illinois Basin: Illinois Geol. Survey Rept. Inv. 209, p. 1–27, pls. 1–6.

SCOTT, HAROLD W., 1942, Conodont assemblages from the Heath Formation, Montana: Jour. Paleontology, v. 16, p. 293–301, pls. 37–40.

STAUFFER, CLINTON, & PLUMMER, HELEN JEANNE, 1932, Texas Pennsylvanian conodonts and their stratigraphic relations: The Univ. of Texas Bull., No. 3201, p. 13–50, pls. I–IV.

YOUNGQUIST, WALTER, & MILLER, A. K., 1949, Conodonts from the Late Mississippian Pella beds of south-central Iowa: Jour. Paleontology, v. 23, p. 617–622, pl. 101.



CHARLES ELIJAH DECKER

JOURNAL OF PALEONTOLOGY, V. 32, NO. 6, P. 1160–1162, NOVEMBER 1958

SOCIETY RECORDS AND ACTIVITIES

MEMORIAL TO CHARLES ELIJAH DECKER (1868–1958)

RAYMOND C. MOORE

CHARLES ELIJAH DECKER, one of the founders of the Society of Economic Paleontologists and Mineralogists who recently was given the high distinction of honorary membership in the Society, during decades was one of the best known and loved teachers of geology and paleontology in the midlands of our country. This is partly indicated by affectionate reference to him as "Daddy Decker," not only by University of Oklahoma students but by many others whom he helped unselfishly, although it must be admitted that this title rarely, if ever, was used in addressing him personally. Dr. Decker was an able and successful teacher who inspired numerous young men and women to pursue a career in earth science. Besides, he was an industrious, enthusiastic research worker who investigated many problems in paleontology, stratigraphy, sedimentation, structural geology, and economic geology.

He survived by nearly a full 20 years the allotted "three score and ten" of a normal long life, maintaining mental and physical vigor in almost incredible degree to the very end. Charles Decker was born on a farm near Dixon, Illinois, on 27 September 1868. Death came unexpectedly and painlessly as he returned from a visit to his garden on 23 August 1958. Only a few months earlier, in March, Dr. Decker journeyed to Los Angeles, California, accompanied by Mrs. Decker, in order to attend the annual meetings of SEPM and AAPG, with the additional purpose of presenting a major scientific paper of his own, on the significance of minute structures of graptolites. This paper was given so ably that it well merited the applause received, despite disagreement on the part of various listeners with some of the interpretations and conclusions offered by him.

Dr. Decker was a charter member of AAPG and a founder of SEPM. With 17 others especially interested in paleontology and microscopic studies of sediments, both generally and as applied to subsurface correlations, Dr. Decker attended a dinner meeting in Dallas, Texas, on 26 March 1926 at which the initial plans for organization of SEPM were discussed. This group included Charles Schuchert, David White, J. J. Galloway, H. V. Howe, Fred and Helen Plummer and several others. A constitution and by-laws were drafted and the Society was formally launched in March, 1927 with 80 charter members, including Dr. Decker.

The scientific writings of Dr. Decker comprise at least 75 bulletins, articles, and notes, chiefly on paleontological subjects but touching other fields as well. Even fossil elephants furnished objects of his attention, along with algae, hydrozoans, trilobites, and chelicerates. Probably as result of studies undertaken in the Arbuckle Mountains region of southern Oklahoma, he soon became especially interested in graptolites and for his work on these fossils he became known nationally and internationally. After studies carried on in the summers of 1932 to 1935 with Dr. Rudolf Ruedemann, at Albany, New York, he pursued independent researches on Cambrian, Ordovician, and Silurian graptolites, describing new species but in particular applying knowledge of these fossils to problems of stratigraphic correlation, both surface and subsurface. Specimens were collected by him and were sent to him from all parts of North America. He studied their morphology in detail and became convinced that the group exhibited affinities with coelenterates, rather than hemichordates such as *Rhabdopleura* and allied forms possessing fusellar and other structural attributes of graptolites.

The long and distinguished career of Dr. Charles E. Decker at the University of Oklahoma, extending from 1916 to 1958, has served to establish a lasting place for him in the regard of his students and of co-workers throughout the profession who knew him. Additionally, his career has contributed materially to enhancement of the reputation of the scholarly institution where he worked and to prestige of the scientific organizations such as AAPG and SEPM which he helped to build.

ANNOUNCEMENTS OF MEETINGS

PRELIMINARY ANNOUNCEMENT OF ANNUAL MEETING AND FIELD TRIP TO BE HELD AT ROSWELL, NEW MEXICO APRIL 2–4, 1959

The annual technical and business meetings of the Permian Basin Section, Society of Economic Paleontologists and Mineralogists will be held Thursday, April 2, 1959, in Roswell, New Mexico. General Chairman is M. Russell Stipp, Standard Oil Company of Texas, Box 746, Roswell, New Mexico. Chairman of the technical program is George A. Sanderson, Shell Oil Company, Box 1509, Midland, Texas.

A field trip in the area of the Sacramento Mountains, New Mexico, is planned for Friday and Saturday, April 3 and 4, 1959. General Chairman is Carl Ulvog, Sunray Mid-Continent Oil Company, Wilco Building, Midland, Texas. Details of the trip will be announced later.

S.E.P.M. SYMPOSIUM, ATLANTIC CITY, 1960

The Paleontological and Mineralogical Aspects of Polar Wandering and Continental Drift

Just thirty years ago the A.A.P.G. conducted a symposium on the theory of continental drift. This was attended by many experts and by supporters of the Wegener hypothesis. Although many of our minds were then set at rest, developments in the past four years necessitate that the subject be reconsidered and re-evaluated. Accordingly, the Executive Committee has planned a full day symposium and an evening open forum discussion on this subject that should create great interest among our members.

Those interested are invited to contact the chairman, Dr. Arthur C. Munyan, Vice Chairman, Research Committee, S.E.P.M., Sohio Petroleum Company, P.O. Box 2558, Billings, Montana.

NEW OFFICERS OF GULF COAST SECTION

President: MARCUS A. HANNA, Gulf Oil Corporation, Houston, Texas
Vice-President: CLAUDE M. QUIGLEY, JR., Standard Oil Company of Texas, Houston, Texas
Secretary: FRED E. SMITH, Texas A. and M. College, College Station, Texas
Treasurer: B. L. HULL, The California Company, New Orleans, Louisiana

NEW OFFICERS OF PACIFIC COAST SECTION

President: CHARLES W. CARY, Union Oil Company of California, Bakersfield, California
Secretary-Treasurer: ALVIN A. ALMGREN, Superior Oil Company, Bakersfield, California

NOTICE

The San Diego Society of Natural History has issued an unrevised reprint of its Memoir Volume I, "Pliocene and Pleistocene Mollusca of California" by U. S. Grant IV, and Hoyt Rodney Gale. This classic of West Coast paleontology has been out of print for some time, and a continuing demand for the work from paleontologists and petroleum geologists led to the reprinting.

The 1036 page volume is a comprehensive taxonomic treatment of the marine mollusks of the Pliocene deposits of California. The first portion is a summary of the stratigraphic relations of the beds in which the fossils were found and the second part lists the species and varieties, with references to their original descriptions, records of occurrence, and brief diagnosis or comparisons. Because of intimate relationships with the fossils of the California Pliocene and Pleistocene, most of the mollusks of similar age from Baja California to Alaska are included, as well as some species from the Miocene and Recent faunas. Thirty two plates illustrate the work.

This Memoir is available from the Librarian, Natural History Museum, Balboa Park, San Diego 1, California.

JOURNAL OF PALEONTOLOGY

INDEX TO VOLUME 32

AUTHOR INDEX

		No.	Page
	ALLEN, BILLY D., see UPSHAW, CHARLES F. (113)		
1.	AMOS, ARTURO J., Some Lower Carboniferous brachiopods from the Volcan formation, San Juan, Argentina	5	838
2.	ARMSTRONG, AUGUSTUS K., Meramecian (Mississippian) endothyrid fauna from the Arroyo Penasco formation, northern and central New Mexico	5	970
3.	AYERS, JOHN C., Treatise on marine ecology and paleoecology, Vol. 1 (review)	3	647
4.	BAIRD, DONALD, New records of Paleozoic diplopod Myriapoda	1	239
5.	BANDY, ORVILLE L., Dominant molluscan faunas of the San Pedro Basin, California	4	703
6.	BOUCOT, ARTHUR J., Age of the Bainbridge limestone	5	1029
7.	BOUCOT, ARTHUR J., *Kozlowskiellina*, new name for *Kozlowskiella* Boucot, 1957 (nomenclatural note)	5	1031
8.	BUTLER, E. ANN, and CHEETHAM, ALAN, A new Cretaceous cribrimorph bryozoan from Louisiana	6	1153
	CAMPBELL, LOIS J., see SUMMERSON, CHARLES H. (99)		
9.	CASTER, KENNETH E., Paleontology, (review)	3	648
10.	CHALONER, W. G., *Polysporia mirabilis* Newberry, a fossil lycopod cone	1	199
	CHEETHAM, ALAN, see BUTLER, E. ANN (8)		
11.	CLARK, DAVID L., *Anisoceras* and *Ancycloceras* from the Texas Cretaceous	6	1076
12.	COBBAN, W. A., Two new species of *Baculites* from the western interior region	4	660
13.	COLLINSON, CHARLES, An addition to the holotype of the Chester nautiloid *Endolobus clorensis*	2	370
14.	COLLINSON, CHARLES and SCOTT, ALAN J., A chitinous anaptychus from the Pennsylvanian of Illinois	2	369
15.	COOGAN, ALAN H., Russian fusulinid genera	2	304
16.	COOPER, G. ARTHUR, The science of paleontology	5	1010
17.	COPELAND, MURRAY J., Redescription of *Ctenobolbina* (Jones) 1891 from the Middle Ordovician of Ottawa, Canada	1	236
18.	CVANCARA, ALAN M., Invertebrate fossils from the Lower Carboniferous of New South Wales	5	846
	CVANCARA, ALAN M., see HOLLAND, F. D., JR. (41)		
19.	DECKER, CHARLES E., and GOLD, IRWIN B., Upper Cambrian graptolites from Virginia and Tennessee	3	401
20.	DECKER, CHARLES E., and HASSINGER, NEAL, What higher magnification is doing for the study of graptolites	4	697
	DODGE, H. W., see THOMPSON, M. L. (108)		
21.	DORR, JOHN A., JR., *Prouintatherium*, new uintathere genus, earliest Eocene, Hoback formation, Wyoming, and the phylogeny of Dinocerata	3	506
22.	DUNBAR, CARL O., On the validity of *Schwagerina* and *Pseudoschwagerina*	5	1019
	ECHOLS, DOROTHY JUNG, see WERNER, COURTNEY (119)		
	EHLERS, GEORGE M., see KESLING, ROBERT V. (44, 46)		
23.	EHLERS, GEORGE M., and KESLING, ROBERT V., *Timeischytes*, a new genus of hemicystitid edrioasteroid from the middle Devonian Four Mile Dam limestone of Michigan	5	933
24.	ELIAS, M. K., Late Mississippian fauna from the Redoak Hollow formation of southern Oklahoma, Part IV, Gastropoda, Scaphopoda, Cephalopoda, Ostracoda, Thoracica, and Problematica	1	1
25.	ELIAS, MAXIM K., *Fenestella ovatiporella*, new name for *F. ovatipora* Elias	3	641
26.	ELLIOTT, GRAHAM F., Classification of thecidean brachiopods	2	373
27.	ETHINGTON, R. L., FURNISH, W. M., and MARKEWICZ, F. J., Ordovician conodonts in New Jersey	4	763
	FAUSTMAN, WALTER, see FRANKEL, LARRY (31)		
28.	FISHER, D. W., *Polylopia* Clark, an Ordovician scaphopod	1	144
29.	FLOWER, ROUSSEAU H., Some Chazyan and Mohawkian Endoceratida	3	433
30.	FRANKEL, LARRY, Nebraska's loess deposits—grassland or woodland environment?	3	638

31. FRANKEL, LARRY, and FAUSTMAN, WALTER, A new Pleistocene Molluscan fauna from Connecticut 3 639
32. FREDERICKSON, E. A., Lower Tremadocian trilobite from Venezuela 3 541
FURNISH, W. M., see MILLER, A. K. (65, 66, 67, 68, 69)
FURNISH, W. M., see ETHINGTON, R. L. (27)
33. GLENISTER, B. F., Upper Devonian Ammonoids from the *Manticoceras* zone, Fitzroy Basin, Western Australia 1 58
GOLD, IRWIN B., see DECKER, CHARLES E. (19)
34. GREEN, MORTON, Arikareean rhinoceroses from South Dakota 3 587
GREGGS, ROBERT A., see OKULITCH, VLADIMIR J. (75)
35. HAAS, OTTO, Recent literature on Mesozoic ammonites 3 624
36. HAMPTON, JOHN S., Subgeneric status in taxonomic paleontology (nomenclatural note) 5 1031
37. HASS, WILBERT, Upper Devonian conodonts of New York, Pennsylvania, and the interior states 4 765
HASSINGER, NEAL, see DECKER, CHARLES E. (20)
38. HATTIN, DONALD E., Regeneration in a Pennsylvanian crinoid spine 4 701
HATTIN, DONALD E., see PERRY, T. G. (82)
HEANY, FRANK, see KESLING, R. V. (47)
39. HENDRIX, W. E., Foraminiferal shell form, a key to sedimentary environment 4 649
40. HESSLAND, IVAR, Some factors in the distribution of fossil cephalopods (review) 5 1035
41. HOLLAND, F. D., JR., and CVANCARA, ALAN M., Crabs from the Cannonball formation (Paleocene) of North Dakota 3 495
42. HOWELL, B. F., Type species for the nemertan worm genus *Legnodesmus* 1 247
43. IMLAY, RALPH W., *Hertleinites*, new name for the Cretaceous ammonite, *Hertleinia*, preoccupied (nomenclatural note) 5 1032
KAUFFMAN, E. G., see KESLING, R. V. (47)
KAUFFMAN, E. G., see STUMM, ERWIN C. (97)
44. KESLING, R. V., Treatise on marine ecology and paleoecology, Vol. 2 (review) 1 248
45. KESLING, R. V., and EHLERS, G. M., *Dolichoscapha*, a new beyrichiid ostracod genus. 1 152
46. KESLING, R. V., and EHLERS, GEORGE M., The edrioasteroid *Lepidodiscus squamosus* (Meek & Worthen) 5 923
47. KESLING, R. V., HEANY, FRANK, KAUFFMAN, E. G., and ODEN, A. L., *Bolbineossia*, a new beyrichiid ostracod genus 1 147
48. KESLING, R. V., and SOHN, I. G., The Paleozoic ostracod genus *Alanella* Boucek, 1936 3 517
KESLING, R. V., see EHLERS, GEORGE M. (23)
49. KIER, PORTER M., Permian echinoids from west Texas 5 889
50. KJELLESVIG-WAERING, ERIK N., Some previously unknown morphological structures of *Carcinosoma newlini* (Claypole) 2 295
51. KJELLESVIG-WAERING, ERIK N., The genera, species and subspecies of the Family Eurypteridae, Burmeister, 1845 ..... 6 1107
52. KLAPPER, GILBERT, An Upper Devonian conodont fauna from the Darby Formation of the Wind River Mountains, Wyoming 6 1082
53. KOENIG, J. W., Fenestrate Bryozoa in the Chouteau group of central Missouri 1 126
54. KOLOSVARY, G., Corals from the Upper Anisian of Hungary 3 636
55. KORNICKER, LOUIS S., Eighth issue of the Publications of the Institute of Marine Science 4 770
56. LADD, H. S., Fossil land shells from western Pacific atolls 1 183
57. LAUBENFELS, M. W. DE, Nomenclature of Porifera, especially concerning the so-called "glass sponges" or Hyalosponges 3 611
LEITH, E. I., see SINCLAIR, G. W. (91)
58. LEUTZE, WILLARD P., Eurypterids from the Silurian Tymochtee dolomite of Ohio 5 937
59. LEVINSON, STUART A., Journal of Paleontological Society of India (Review) 2 384
60. LINTZ, JOSEPH, JR., The fauna of the Ames and Brush Creek shales of the Conemaugh formation of western Maryland 1 97
61. LINTZ, JOSEPH, JR., and LOHR, LEWIS S., Two new invertebrates from the Mississippian of Nevada 5 977
62. LOCHMAN, CHRISTINA, *Sulcocephalus* Wilson 1948 to replace *Berkeia* Resser, 1937, and *Burnetiella* to replace *Burnetia* Walcott, 1924 ..... 1 247
63. LOCHMAN-BALK, CHRISTINA, and WILSON, JAMES LEES, Cambrian biostratigraphy in North America 2 312
LOHR, LEWIS S., see LINTZ, JOSEPH, JR. (61)
MARKEWICZ, F. J., see ETHINGTON, R. L. (27)
64. MATSUMOTO, TATSURO, and MILLER, HALSEY W., JR., Cretaceous ammonites from the spillway excavation of Cedar Bluff Dam, Trego County, Kansas 2 351

65. MILLER, A. K., and FURNISH, W. M., Middle Pennsylvanian Schistoceratidae (Ammonoidea) 2 253
66. MILLER, A. K., and FURNISH, W. M., Goniatites of the Burlington limestone in Missouri 2 269
67. MILLER, A. K., and FURNISH, W. M., Manuscript copy for the Journal of Paleontology 2 374
68. MILLER, A. K., and FURNISH, W. M., Permian ammonoids from the Colorado Plateau 4 682
69. MILLER, A. K., and FURNISH, W. M., The goniatite genus *Anthracoceras* 4 684
70. MILLER, HALSEY W., A new genus and species of Permian ophuiroid from Kansas. 2 357

MILLER, HALSEY W., JR., see MATSUMOTO, TATSURO (64)

71. MITRA, KARUN C., Variation in *Goniorhynchia boueti* from Normandy and Dorset.. 5 992
72. MORKHOVEN, F. P. C. M. VAN, On the validity of the ostracod genera *Glyptobairdia* and *Bairdoppilata* 2 366
73. MYERS, DONALD A., Stratigraphic distribution of some fusulinids from the Thrifty formation, Upper Pennsylvanian, Central Texas 4 677
74. NOREM, W. L., Keys for the classification of fossil spores and pollen 4 666

ODEN, A. L., see KESLING, R. V. (47)

75. OKULITCH, VLADIMIR J., and GREGGS, ROBERT G., Archaeocyathid localities in Washington, British Columbia, and the Yukon Territory 3 617
76. OLIVER, WILLIAM A., JR., Significance of external form in some Onandagan rugose corals 5 815
77. OLSEN, STANLEY J., Some problematical carnivores from the Florida Miocene 3 595
78. PALMER, A. R., Morphology and ontogeny of a Lower Cambrian ptychoparoid trilobite from Nevada 1 154

PALMER, ERNEST J., see UNKLESBAY, A. G. (112)

79. PALMER, K. V. W., Viviparous *Turritella pilsbryi* Gardner 1 210
80. PAULSON, OSCAR L., JR., A new species of the Eocine echinoid *Periarchus* 2 362
81. PEABODY, FRANK E., An embolomerous amphibian in the Garnett fauna (Pennsylvanian) of Kansas 3 571
82. PERRY, T. G., and HATTIN, DONALD E., Astogenetic study of fistuliporoid bryozoans. 6 1039
83. PURI, HARBANS S., Eocene and Oligocene Ostracoda of Belgium, (review) 2 383
84. QUINN, JAMES HARRISON, New Pleisotocene *Asinus* from southwestern Arizona 3 603
85. REXROAD, CARL B., The conodont homeomorphs *Taphrognathus* and *Streptognathodus* 6 1158
86. RICE, N. E., Occurrence of glass sponges in the Devonian of West Virginia 1 244
87. RIGBY, J. KEITH, Two new Upper Paleozoic hydrozoans 3 583
88. RIGBY, J. KEITH, Lower Ordovician graptolite faunas of western Utah 5 907
89. RIGBY, J. KEITH, Frequency curves and death relationships among fossils 5 1007
90. ROSS, REUBEN J., Trilobites in a pillow-lava of the Ordovician Valmy formation, Nevada 3 559

SCOTT, ALAN J., see COLLINSON, CHARLES (14)

91. SINCLAIR, G. W., and LEITH, E. I., New name for an Ordovician shale in Manitoba 1 243
92. SKOLNICK, HERBERT, Lower Cretaceous Foraminifera of the Black Hills area 2 275
93. SLOSS, L. L., Paleontologic and lithologic associations 4 715
94. SOHN, I. G., Chemical constituents of ostracodes; some applications to paleontology and paleoecology 4 730

SOHN, I. G., see KESLING, ROBERT V. (48)

95. STANLEY, EDWARD A., Some Mississippian conodonts from the High Resistivity shale of the Nancy Watson No. 1 well in northeastern Mississippi 3 459
96. STEWART, WENDELL J., Some fusulinids from the upper Strawn, Pennsylvanian of Texas 6 1051
97. STUMM, ERWIN C., and KAUFFMAN, ERLE G., Calymenid trilobites from the Ordovician rocks of Michigan 5 943
98. SUMMERSON, C. H., Arenaceous foraminifera from the Middle Devonian limestones of Ohio 3 544
99. SUMMERSON, CHARLES H., and CAMPBELL, LOIS J., Holothurian sclerites from the Kendrick shale of eastern Kentucky 5 961
100. SYLVESTER-BRADLEY, P. C., The description of fossil populations 1 214
101. TASCH, PAUL, Permian conchostracan-bearing beds of Kansas. Part I. Jester Creek section—fauna and paleoecology 3 525
102. TASCH, PAUL, Note on *Bileaia* Kobayashi, 1954 *nomen nudum* 3 637
103. TASCH, PAUL, The internal structure of *Diplograptus peosta* Hall 5 1021
104. TASCH, PAUL, Novojilov's classification of fossil conchostracans—a critical evaluation. Part I. Family Leaiidae 6 1094
105. TAYLOR, DWIGHT W., Geologic range and relationships of the freshwater snail *Anisus pattersoni* 6 1149

106. THALMANN, HANS E., Bibliography and index to new genera, species, and varieties of Foraminifera for the year 1955 ..... 4 737
107. THOMPSON, M. L., Manuscript style 2 373
108. THOMPSON, M. L., DODGE, H. W., and YOUNGQUIST, WALTER, Fusulinids from the Sublett Range, Idaho 1 113
TODD, ROBERT G., see UPSHAW, CHARLES F. (113)
109. TRIPP, RONALD PEARSON, Stratigraphic and geographical distribution of the named species of the trilobite superfamily Lichacea 3 574
110. TRUMBULL, ELLEN JAMES, Shumard's type specimens of Tertiary mollusks from Oregon and other types formerly at Washington University, St. Louis 5 893
111. TURNBULL, W. D., The type of *Phlegethontia linearis* Cope 1 245
112. UNKLESBAY, A. G., and PALMER, ERNEST J., Cephalopods from the Burgner Formation in Missouri 6 1071
113. UPSHAW, CHARLES F., TODD, ROBERT G., and ALLEN, BILLY D., Fluoridization of microfossils: Addenda 2 372
114. VALENTINE, JAMES W., Late Pleistocene megafauna of Cayucos, California, and its zoogeographic significance 4 687
115. VAUGHN, PETER PAUL, On the geologic range of the labyrenthodont amphibian *Eryops* 5 918
116. VAUGHN, PETER PAUL, On a new pelecosaur from the lower Permian of Oklahoma, and on the origin of the family Caseidae 5 981
117. VON DER OSTEN, ERIMAR, *Astrocoenia barranquiniana*, a new name for *Astrocoenia minima* von der Osten 1 247
118. WELLS, J. W., Note on two forgotten species of Paleozoic tabulate corals from New York 1 242
119. WERNER, COURTNEY, and ECHOLS, DOROTHY JUNG, Three dimensional graptolites in the Maquoketa shale (Upper Ordovician) of Missouri 5 1026
120. WHITE, THEODORE E., The braincase of *Camarasaurus lentus* (Marsh) 3 477
WILSON, JAMES LEES, see LOCHMAN-BALK, CHRISTINA (63)
121. WOODLAND, ROLAND BERT, Stratigraphic significance of Mississippian endothyrid Foraminifera in central Utah 5 791
122. YOUNG, KEITH, *Graysonites* a Cretaceous ammonite in Texas 1 171
123. YOUNG, KEITH, Cenomanian (Cretaceous) ammonites from Trans-Pecos, Texas ... 2 286
YOUNGQUIST, WALTER, see THOMPSOH, M. L. (108)

SUBJECT INDEX

Absonodaphoenus: new genus, Miocene carnivores (77)
Alanella: Devonian ostracode (48)
Ammonites: Cretaceous, Kansas (64); Cretaceous, Texas (11, 123)
Ammonoids: Devonian, Western Australia (33)
Amphibians: Pennsylvanian, Kansas (81); range of *Eryops* (115)
Anaptychus: Pennsylvanian, Illinois (14)
Anisoceras: Cretaceous, Texas (11)
Ancyloceras: Cretaceous, Texas (11)
Anisus pattersoni: snail, Cenozoic (105)
Anthracoceras: Carboniferous, Upper Silesia (69)
Archaeocyathids: Cambrian, Washington, British Columbia and Yukon Territory (75)
Argentina: Carboniferous brachiopods (1)
Arizona: Permian cephalopods (68); Pleistocene horse (84)
Astrocoenia: Cretaceous, Venezuela (117)
Association of fossils and rock types (93)
Australia: Devonian ammonoids (33)
Baculites eliasi: new species, cephalopod (12)
Baculites scotti: new species, cephalopod (12)
Bainbridge limestone, age of (6)
Bairdoppilata: recent ostracode (72)
Bileaia, nomen nudum, conchostracan (102)
Biometrical analysis (100)
Bolbineossia: new genus, ostracode (47)

Brachiopods: Carboniferous, Argentina (1); Lower Carboniferous, New South Wales (18); new suborder Thecideoidea (26); specific variation (71)
Bryozoa: astogeny of fistuliporoids (82); Cretaceous, Louisiana (8); Mississippian, Missouri (53); Silurian, Tennessee, Kansas (82)
Burnetiella replaces *Burnetia* (62)
California: living molluscan faunas (5); Pleistocene invertebrate megafauna (114); Tertiary foraminifera (39)
Camarasaurus: Jurassic dinosaur, Wyoming (120)
Camarocarcinus, new genus, Paleocene crabs (41)
Cambrian: archaeocyathids, Washington, British Columbia and Yukon Territory (75); biostratigraphy (63); graptolites, Virginia and Tennessee (19); trilobite, Nevada (78)
Cambro-Ordovician trilobite facies (63)
Canada: Ordovician ostracode (17)
Carboniferous: brachiopods, Argentina (1); cephalopod, Upper Silesia (69); lycopod cone (10)
Carcinosoma: Silurian eurypterid, Indiana (50)
Carnivores: Florida Miocene (77)
Cenozoic: freshwater snail, Central and Western United States (105)
Cephalopoda: Cretaceous ammonites, Kansas (64); Cretaceous, Texas (123); Mississippian, Missouri (66); Mississippian, Oklahoma (24); Ordovician nautiloids (29); Pennsylvanian ammonoids (65, 112)
Chazyoceras: new genus, Ordovician cephalopod (29)
Chemical constituents: living ostracodes (94)
Clarkeolepis, new genus, Thoracica (24)
Colobomycter: new genus, Permian pelycosaur, Oklahoma (116)
Colorado: Late Cretaceous cephalopod (12)
Conchostracans: Permian, Kansas (101); classification (104)
Conodonts: Devonian, New York, Pennsylvania, and interior states (37); Wyoming (52); homeomorphs, *Taphrognathus* and *Streptognathodus* (85); Mississippian, Mississippi (95); Ordovician, New Jersey (27)
Corals: Cretaceous Venezuela (117); external form (76); Triassic, Hungary (54)
Crabs: Paleocene, North Dakota (41)
Crassifimbra walcotti: trilobite, Cambrian Nevada (78)
Cretaceous: ammonites, Kansas (64); bryozoan, Louisiana (8); Foraminifera, Wyoming, South Dakota (92); Texas ammonite (11, 122, 123)
Crinoid: Pennsylvanian, regeneration (38)
Ctenobolbina clavigera: ostracode, Ordovician, Canada (17)
Death relationships among fossils (89)
Delocrinus wolforum: regeneration of spine (38)
Devonian: ammonoids, Western Australia (33); conodonts, New York, Pennsylvania, and interior states (37); Wyoming (52); coral, New York (118); edrioasteroid, Michigan (23); glass sponges, Virginia (86); Ohio Foraminifera (98); ostracode, New York (46); rugose corals (76)
Dimeqalasma eurekensis: new species, brachiopod, Mississippian, Nevada (61)
Dinosaur: Jurassic, Wyoming (120)
Diplograptus peosta: internal structure, Ordovician graptolite (103)
Dolichoscapha: new genus, ostracode (45)
Edrioasteroid: Devonian, Michigan (23); *Lepidodiscus squamosus* (46)
Elkoceras volborth: new genus and species, nautiloid, Mississippian, Nevada (61)
Eocene and Oligocene Ostracoda of Belgium (83)
Eocene: Echinoid, North Carolina (80); uintathere, Wyoming (22)
Emmonsoceras: new genus, Ordovician cephalopod (29)
Endolobus: Mississippian nautiloid, Illinois (13)
Endothyra: Mississippian, New Mexico (2)
Endothyrids: Mississippian, Utah (121)
Environment: living molluscan faunas, California (5)
Erieopterus: new genus, eurypterid (51)
Erieopterus hypsophthalmus: new species, eurypterid (51)
Eryops: range of (115)
Eurypteridae: synopsis, review, classification (51)
Eurypterus remipes laculatus: new subspecies, eurypterid (51)
Eurypterus remipes quebecensis: new subspecies, eurypterid (51)
Eurypterus remipes swartzi: new subspecies, eurypterid (51)
Eurypterids: Silurian, Indiana (50); Silurian, Ohio (58)
Fairliella, new genus, arenaceous foraminifer (98)
Fenestella: Mississippian bryozoans (53)
Fenestella ovatiporella: new name, Pennsylvania, Missouri (25)

Flexicalymene: Ordovician, Michigan (97)
Florida: Miocene carnivores (77)
Fluoridization of microfossils (113)
Foerstephyllum striatulum: Middle Ordovician coral (118)
Foraminifera: arenaceous, Cretaceous, Wyoming and South Dakota (92); bibliography of new genera, species and varieties for 1955 (106); Devonian, Ohio (98); Mississippian, Utah (121); shell form (39)
Fossil populations (100)
Fossil spores and pollen: classification (74)
Frequency curves and death relationships among fossils (89)
Freshwater snail: Cenozoic, Central and Western United States (105)
Frumentela exempla: new genus, new species, fusulinid (96)
Fusiella texana: new species, fusulinid (96)
Fusulina beltatula: new species, fusulinid (96)
Fusulina brazoensis: new species, fusulinid (96)
Fusulina cappsensis: new species, fusulinid (96)
Fusulina gordonensis: new species, fusulinid (96)
Fusulina valida: new species, fusulinid (96)
Fusulina vintonensis: new species, fusulinid (96)
Fusulina whitakeri: new species, fusulinid (96)
Fusulinid genera, Russian (15)
Fusulinids: on validity of *Schwagerina* and *Pseudoschwagerina* (22); Pennsylvanian-Permian, Idaho (108); Pennsylvanian, Texas (73, 96)

Gastropoda: Miocene, Virginia (79); Mississippian, Oklahoma (24); Pleistocene, California (114)
Glass sponges: Devonian, Virignia (86)
Glyptobairdia: recent ostracode (72)
Goniorhynchia boueti, specific variation (71)
Gordonites: new genus, cephalopod (69)
Granuliferella: Mississippian, New Mexico (2)
Graptolites: Cambrian, Virginia and Tennessee (19); Lower Ordovician, Utah (88); Ordovician (103); Ordovician, Missouri (119); reproductive structures (20)
Graysonites: Cretaceous ammonite (112)

Hertleinites: new name, Cretaceous ammonite (43)
Hesperoherpeton: new genus, amphibian, Pennsylvanian, Kansas (81)
Holothurian sclerites: Pennsylvanian, Kentucky (99)
Horse: Pleistocene, Arizona (84)
Hungary: Triassic, corals (54)
Hydrozoans: Paleozoic western United States (87)

Idaho: Pennsylvanian-Permian fusulinids (108)
Icriodus darbyensis: new species, conodont (52)
Icriodus mehli: new species, conodont (52)
Illinois: Mississippian cephalopod (13); Pennsylvanian anaptychus (14)
Indiana: Silurian eurypterid (50)
Institute of Marine Science (55)

Jurassic: dinosaur, Wyoming (120)

Kaibab Formation: Permian cephalopod, Arizona (68)
Kansas: Cretaceous ammonites (64); Pennsylvanian amphibian (81); Permian conchostracans (101); Permian ophiuroid (70)
Kentucky: Pennsylvanian holothurian sclerites (99)
Kozlowskiellina, new name (7)

Land snails: Quaternary and Miocene, western Pacific atolls (56)
Late Cretaceous: Pierre shale, cephalopod (12)
Leaiidae: classification (104)
Legnodesmus, worm genus (42)
Lepidodiscus squamosus (Meek & Worthen), edrioasteroid (46)
Lithocongruency (93)
Lithologic and paleontologic associations (93)
Loess deposits: Nebraska (30)
Louisiana: bryozoan, Cretaceous (8)
Lower Carboniferous brachiopods (18)
Lower Ordovician: graptolites, Utah (88)
Lower Tremadocian: trilobite, Venezuela (32)

Manitoba: Ordovician Gunn member, Stony Mountain formation (91)
Manuscript copy style (67)

Manuscript style (107)
Mesobeloceras: new genus, Devonian ammonoid (33)
Mesozoic ammonite literature (35)
Michigan: Devonian edrioasteroid (23); new Silurian ostracode genus (47); Ordovician trilobites (97); Silurian, ostracodes (45)
Miocene: carnivores, Florida (77); gastropod, Virginia (79); sedimentary environment (39); snails, western Pacific atolls (56); South Dakota rhinoceroses (34)
Mississippi: Mississippian conodonts (95)
Mississippian: brachiopod, Nevada (61); Bryozoa, Missouri (53); cephalopod, Illinois (13); cephalopod, Nevada (61); cephalopods, Missouri (66); conodonts, Mississippi (95); endothyrids, New Mexico (2); southern Oklahoma (24); Foraminifera, Utah (121)
Missouri: Mississippian Bryozoa (53); Mississippian cephalopods (66); Ordovician graptolites (119); Pennsylvanian cephalopods (112)
Molluscan faunas: living, California (5); Pleistocene, Connecticut (31)
Mollusks: Pleistocene, California (114)
Montana: Late Cretaceous cephalopod (12)
Morphologic classification: spores and pollen (74)
Myriapoda: Paleozoic millipedes (4)
Nevada: Cambrian trilobite (78); Mississippian brachiopod and nautiloid (61); Ordovician trilobites (90)
New Jersey: Ordovician conodonts (27)
New Mexico: Mississippian endothyrids (2)
New South Wales: Lower Carboniferous brachiopods (18)
New York: Devonian conodonts (37); Devonian, Ordovician corals (118); Devonian ostracode (48)
North Carolina: Eocene echinoid (80)
North Dakota: Paleocene crabs (41)
Ohio: Devonian Foraminifera (98); Silurian eurypterids (58)
Oistodus: Ordovician conodont (27)
Oklahoma: Mississippian, Gastropoda, Scaphopoda, Cephalopoda, Ostracoda, Thoracica, Problematica (24); Permian pelycosaur (116)
Ophiuraster burrisi: new genus, Permian ophuiroid (70)
Ophiuroid: Permian, Kansas (70)
Ordovician: biostratigraphy (63); conodonts, New Jersey (27); coral, New York (118); graptolite (103); Gunn member, Stony Mountain formation, Manitoba (91); Missouri graptolites (119); nautiloids (29); ostracode, Canada (17); scaphopod, Tennessee (28); trilobites, Michigan (97); trilobites, Nevada (90); trilobite, Venezuela (32)
Ostracoda: chemical constituents (94); Devonian, New York (48); Mississippian, Oklahoma (24); Ordovician, Canada (17); Silurian, Michigan (45, 47)
Paleontology, review of (9)
Paleocene: crabs, North Dakota (41)
Paleontological Society of India (59)
Papillicalymene: Ordovician, Michigan (97)
Paramillerella dogbendensis: new species, fusulinid (96)
Pelecypoda: Pleistocene, California (114)
Pennsylvania: Devonian conodonts (37); Pennsylvanian fauna, Maryland (60)
Pennsylvanian: amphibian, Kansas (81); cephalopods (65, 112); fauna from Conemaugh, Pennsylvania (60); fusulinids, Idaho (108); Texas (95); holothurian sclerites, Kentucky (99); Illinois anaptychus (14); Nova Scotia, millipedes (4); Ohio millipedes (4); Ohio vertebrate (111); regeneration in crinoid spine (38); Texas fusulinids (73)
Periarchus: Eocene echinoid, North Carolina (80)
Permian: cephalopod, Arizona (68); conchostracans, Kansas (101); echinoid, West Texas (49); fusulinids, Idaho (108); ophiuroid, Kansas (70); pelycosaur, Oklahoma (116); Texas millipedes (4)
Phlegethontia linearis: vertebrate, Pennsylvanian, Ohio (111)
Phragmodus: Ordovician conodont (27)
Plectofusulina franklinensis: new genus, new species, fusulinid (96)
Pleistocene: horse, Arizona (84); invertebrate megafauna, California (114)
Pliocene: sedimentary environment (39)
Polygnathus wyomingensis: new species, conodont (52)
Polylopia: Ordovician scaphopod (28)
Polysporia: lycopod cone, Carboniferous (10)
Porifera: nomenclature of "glass sponges" (57)
Presidential address (16)
Prouintatherium: new genus, Eocene uintathere (21)
Pseudogastrioceras mckeei: new species, cephalopod (68)
Pseudoschwagerina: validity of (22)

Quaternary: snails, Western Pacific atolls (56)
Recent ostracoda (72)
Rhinoceroses: Miocene, South Dakota (34)
Rhiniopora spooneri: new species, bryozoan (8)
Russian fusulinid genera (15)
Scaphopod: Ordovician, Tennessee (28)
Schistoceratidae: Pennsylvanian cephalopods (65)
Schwagerina: validity of (22)
Science of paleontology: Presidential address (16)
Silurian: Bainbridge limestone (6); bryozoa, Tennessee, Kansas (82); eurypterids, Ohio (58); Indiana eurypterid (50); ostracode, Michigan (47); ostracodes, Michigan (45)
South Dakota: Cretaceous foraminifera (92); Late Cretaceous cephalopod (12); Miocene rhinoceroses (34)
Spectrographic analyses: ostracodes (94)
Subgeneric status in taxonomic paleontology (36)
Sulcocephalus replaces *Berkeia* (62)
Temnocheilus seawrighti: new species, nautiloid (112)
Tennessee: Cambrian graptolites (19)
Tennessee: Ordovician scaphopod (28)
Tertiary mollusks: Shumard's types from Oregon (110)
Texas: Cretaceous ammonites (11, 122, 123); Pennsylvanian fusulinids (73, 96)
Thecideoidea: new suborder, brachiopods (26)
Thrifty formation: fusulinids (73)
Timeischytes: new genus, Devonian edrioasteroid (23)
Trachypora vermiculosa: Middle Devonian coral (118)
Treatise on marine ecology and paleoecology (3)
Triassic: corals, Hungary (54)
Triendoceras: new genus, Ordovician cephalopod (29)
Trilobite: Cambrian, Nevada (78); facies (63); Ordovician, Venezuela (32); distribution of super family Lichacea (109); synonyms (62); Ordovician, Nevada (90)
Triticites: Pennsylvanian, fusulinid, Texas (73)
Turritella pilsbryi: gastropod, Miocene (79)
Typological analysis (100)
Uintathere: Eocene, Wyoming (21)
Utah: Lower Ordovician graptolites (88); Mississippian Foraminifera (121)
Vaningenoceras: new genus, Ordovician cephalopod (29)
Venezuela: Cretaceous coral (117); Ordovician trilobite (32)
Virginia: Cambrian graptolites (19); Devonian, glass sponges (86)
Viviparous gastropod (79)
Washington University: Type specimens formerly at Washington University (110)
Weikkoella, new genus, arenaceous Foraminifera (98)
West Texas: Permian echinoid (49)
Western Pacific atolls: snails, Quaternary, Miocene (56)
Western United States: hydrozoans (87)
Wyoming: conodonts, Devonian (52); Cretaceous Foraminifera (92); Eocene uintathere (21); Jurassic dinosaur (120); Late Cretaceous cephalopod (12)
Xenechinus: new genus, Permian echinoid (49)

PROTEXO BAGS
• Strong • Sift-proof
• Geologist-designed
• Highest Quality Cambric Cloth

MAGIC MARK TAGS
• Water-Insect-and Mildew-proof
• Guaranteed to keep even ordinary pencil markings legible.

...the sand sample that can't be identified when it reaches the lab—the sample that *could* influence decisions concerning future development of an entire field—the sample that is lost forever *because of a faulty container*...

THIS handful of sand can cost you thousands of dollars!

Sand samples are important. They cost at least $2.00 each to collect and process. Yet up to 25% are dumped uncut because of illegible tags or inferior bags. Lost is the investment in handling costs. Forever lost is valuable information. Stop such losses with HUBCO PROTEXO SAND SAMPLE BAGS. We'd like to tell you the whole story behind HUBCO Protexo Bags. For more information, a sample and dealer's name *mail in the coupon.*

HUBCO Protexo Bags were designed with the GEOLOGIST in mind.

HUTCHINSON BAG CORPORATION Dept. JP
P. O. Box 868, Hutchinson, Kansas

Name_____

Company_____

Street_____

City_____ State_____

WILEY

Coming in January, 1959—a new text that brings into focus the over-all picture of paleontology

TIME, LIFE, AND MAN

The Fossil Record

By R. A. STIRTON

University of California, Berkeley

Outlines methods and principles . . .

Designed for the beginning student or the general reader interested in the history of life on earth, this comprehensive treatment outlines methods and general principles. It includes a condensed classification of plants and animals and the sequence of life and environments, plus special material on selected topics, such as dinosaurs, horses, ammonites, birds, and man. The history of paleontology is detailed, and attention is directed to historical incidents throughout the text. A special feature is the inclusion of the methods of locating, collecting and curating specimens as well as preparing them for study. A bibliography lists sources for further study.

Emphasizes these six major objectives . . .

- Identification
- Form and function
- Associations of plants and animals
- Evolution in the different groups of organisms
- Dispersal and distribution of plants and animals through time and space
- Correlation

Ready January, 1959 Approx. 572 pages. Illus.

College Edition Prob. $7.50

Reserve your examination copy now.

JOHN WILEY & SONS, Inc.

440 Fourth Avenue New York 16, N. Y.

McLEAN PALEONTOLOGICAL LABORATORY

Quick utilization of literary evidence in paleontology, coupled to the collection of specimens and information. Complete facilities for research. Trained personnel for general paleontological studies.

Junius D. McLean, Jr., Box 716, Alexandria, Virginia, U.S.A.

SUPERLATIVE FOSSILIUS

Our stock of Index fossils has been recognized as incomparable—the quality unsurpassed—our prices unbelievably low! Now we offer similar quality service to our colleagues by searching for the rare and difficult-to-find fossil specimen. Tell us what you need for and we will do our best to locate the material. Our fossil lists and services always prompt.

PALEONTOLOGICAL RESEARCH LABORATORY
888 N. Mulberry Street
Jonesville, North Carolina

Sea Shells of Tropical West America

MARINE MOLLUSKS FROM LOWER CALIFORNIA TO COLOMBIA

A. Myra Keen

Assistant Professor of Paleontology, Stanford University

This is the first attempt to list and provide illustrations of the rare shells of the tropical area of the Pacific marine province. Concise descriptions of 1,682 species of sea shells, with over 1,500 illustrations, cover most of the described forms larger than about one-fifth of an inch in length. About 70 type species are figured for the first time. The notes on geographic distribution of the species indicate where the collector might expect to find them, and an extensive bibliography is included. 16 pages of four-color plates.

640 pages, $12.50

Stanford University Press
Stanford, California